

~ Dictionary ~

of

TECHNICAL WATER, WATER QUALITY, ENVIRONMENTAL, NATURAL RESOURCE, AND WATER-RELATED WORDS

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[Note on word presentation and cross references: Defined words are initially presented in **Capitalized Bold**; cross-referenced words within definitions are presented the first time in *Capitalized Italics*. Words are generally presented according to their common pronunciation, i.e., “Absorption Tower” versus “Tower, Absorption”. Acronyms, where presented, will either present the full word term or refer back to the full word, unless the acronym is more commonly used. In addition, words are presented according to the whole root word’s most accepted spelling, therefore “Water Vapor” will appear before “Waterborne”.]

A

A–Horizon — The uppermost zone in the *Soil Profile*, from which soluble *Salts* and *Colloids* are leached, and in which organic matter has accumulated. Generally this represents the most fertile soil layer and constitutes part of the *Zone of Eluviation*.

A Posteriori Classification — (Statistics) A classification made based upon the results of experimentation. Contrast with *a Priori Classification*.

A Priori Classification — (Statistics) A classification made prior to experimentation. Contrast with *a Posteriori Classification*.

Abandoned Channel — See *Oxbow*.

Abandoned Cliff — (Geology) A cliff that is no longer subject to wave attack because of a relative drop of sea level.

Abandoned Water Right — A water right which has not been put to *Beneficial Use* for generally five or more years, in which the owner of the water right states that the water right will not be used, or takes such actions that would prevent the water from being beneficially used. Compare to *Forfeited Water Right*.

Abandoned Well — A well which is no longer used or a well removed from service; a well whose use has been permanently discontinued or which is in a state of such disrepair that it cannot be used for its intended purpose. Generally, abandoned wells will be filled with concrete or cement grout to protect underground water from waste and contamination.

Abandonment — To give up the right to make a beneficial use of water as authorized by a water appropriation. A well or test hole whose original purpose and use has been permanently discontinued, which is in such a state of disrepair that its original purpose cannot be reasonably achieved, or which is abandoned pursuant to existing regulations or statutes.

Abandonment (Water Right) — (1) Generally refers to the intentional surrender of a water right by virtue of nonuse. (2) Failure to put a water right to *Beneficial Use* for generally five or more years, in which the owner of the water right states that the water right will not be used, or takes such actions that would prevent the water from being beneficially used. Also see *Abandoned Water Right*. Compare to *Forfeiture (Water Right)*.

Abandonment of a Dam — In a legal sense, abandonment is most precisely described as transfer of all rights, title and interest in a dam to the current property owner. Abandonment may also involve the slow but resolute erosion of rights to a dam by non-use,

physical destruction, lack of maintenance or intent of same. In this latter instance the final determination of legal abandonment can only be decided by the court holding jurisdiction.

Abatement — Reducing the degree or intensity of, or eliminating, pollution, as a water pollution abatement program.

Abiota — Those non-living factors which are present in and affect the characteristics of a given ecosystem.

Ablation — (1) The process by which ice and snow waste away as a result of melting and/or evaporation. (2) The quantity of ice or snow lost in this manner. (3) The erosive processes by which a glacier is reduced.

Ablation Area — That part of the surface of a glacier or snowfield where annual ablation exceeds annual accumulation. Also referred to as the *Zone of Ablation*.

Ablation Factor — The rate at which a surface of ice or snow melts or evaporates.

Ablation Moraine — (Geology) A pile or layer of loosely consolidated rock debris that either overlies ice in the *Ablation Area* of a glacier or rests on ground moraine derived from the glacier.

Above — Upriver from a point or viewing location.

Abrasion — Removal of stream-bank soil as a result of sediment-laden water, ice, or debris rubbing against the bank.

Abrasion Shoreline — See *Retrograding Shoreline*.

ABS — See *Alkyl Benzene Sulfonate*.

Abscissa (Symbol X) — (Mathematics) The coordinate representing the position of a point along a line perpendicular to the y-axis (*Ordinate*) in a *Plane Cartesian Coordinate System*.

Abscission — The dropping of leaves from a plant. Premature abscission in certain plant species frequently results from excessive exposure to certain air contaminants.

Absolute Humidity — (1) The actual weight of water vapor contained in a unit volume of the atmosphere, usually expressed in grams of water per kilogram of air. (2) (Physics) The ratio of the mass of water vapor present in a mixture to the volume it occupies. Compare to *Relative Humidity*. Also referred to as *Vapor Concentration* or *Vapor Density*.

Absolute Temperature (T) — A temperature expressed on the thermodynamic scale, measured from *Absolute Zero*, or 0°Kelvin (K), also equivalent to −273.15° Celsius (C) or −459.67° Fahrenheit (F).

Absolute Zero — The zero value of thermodynamic temperature, or 0°Kelvin (K), also equivalent to −273.15° Celsius (C) on the *Centigrade Temperature Scale* or −459.67° Fahrenheit (F) on the *Fahrenheit Temperature Scale*.

Absorbed Dose — The amount of a chemical that enters the body of an exposed organism.

Absorber — A material capable of taking in a substance, such as oil, as a sponge takes up water.

Absorption — (1) The passage of water into the *Lithosphere*. (2) The entrance of water into the soil or rocks by all natural processes, including the infiltration of precipitation or snowmelt, gravity flow of streams into the valley alluvium into sinkholes or other large openings, and the movement of atmospheric moisture. (3) The uptake of water or dissolved chemicals by a cell or an organism (as tree roots absorb dissolved nutrients in soil). (4) More generally, the process by which substances in gaseous, liquid, or solid form dissolve or mix with other substances. Not to be confused with *Adsorption*.

Absorption Factor — The fraction of a chemical making contact with an organism that is absorbed by the organism.

Absorption Loss — The loss of water by *Infiltration* or *Seepage* into the soil during the process of priming, i.e., during the initial irrigation of a field; generally expressed as flow volume per unit of time.

Absorption Tower — (Air Quality) An air pollution control device in which contaminated air is passed through a tower containing substances (packing) possessing large surface area. Water is passed over the packing material in a countercurrent fashion, i.e., in a direction opposite to the passage of the air, and the air contaminants are then absorbed into the liquid. Also referred to as *Packed Tower*, *Spray Tower*, or *Tray Tower*.

Abstraction — (1) The process of merging one or more streams into another stream having greater erosional activity. (2) The portion of precipitation that does not become direct runoff.

Abutment (of a Dam) — The part of a valley side wall against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section to take the thrust of an *Arch Dam* where there is no suitable natural abutment. Right and left abutments are designated as one looks downstream.

Abutment Seepage — Reservoir water that moves through seams or pores in the dam's natural *Abutment* material and exists as seepage.

Abysmal — See *Abyssal*.

Abyss — (1) An indefinite term referring to a deep part of the ocean, generally regarded as the area more than 1,000 meters (3,300 feet) deep. Also see *Abyssal Zone*.

Abyssal — (Oceanography) (1) Of or relating to the bottom waters of the ocean depth. (2) Of or relating to the deepest regions of the ocean and the organisms inhabiting that marine environment. (3) (Geology) Of or relating to the region deep within the earth. Also referred to as *Abysmal*.

Abyssal Zone — (Oceanography) (1) The bottom of a deep ocean. (2) The area of the great ocean depths, roughly between 2,000 and 6,000 meters (6,600–20,000 feet) deep (except as it includes abyssal hills or knolls, which may rise as high as 1,000 meters). This area occupies about three-fourths of the total area of the Earth's oceans. Also see *Bathyal Zone* and *Euphotic Zone*.

Acclimatization — (1) The process by which one becomes accustomed to new environmental conditions. (2) The physiological adjustment or adaptation by an organism to new physical and/or environmental conditions. With respect to water, it is frequently used in reference to the ability of a species to tolerate changes in water temperature, degradation of water quality, or increased levels of salinity.

Accreting Areas — Landscape positions where soil material accumulates through deposition from higher elevations or upstream positions more rapidly than is being lost through erosion.

Accretion — (1) The growth of a precipitation particle by the collision of a frozen particle with a supercooled liquid water droplet

which freezes upon impact. (2) The slow addition to land by deposition of water-borne sediment. An increase in land along the shores of a body of water, as by *Alluvial* deposit.

Accretion Ridge — (Geology) A beach ridge found inland from the modern beach, indicating that the coast has been built out toward the sea.

Accumulated Overdraft — The amount of water necessary to be replaced in the intake area of the groundwater basin to prevent the landward movement of ocean water into the fresh groundwater body.

Accumulation — (1) The addition of ice or snow to the surface of a glacier or snowfield by condensation, snowfall, or any other process. (2) The quantity of ice or snow that is added to a *Glacier* or snowfield by such a process. Also see *Alimentation*.

Accumulation Area — That part of the surface of a *Glacier* or snowfield where annual *Accumulation* exceeds annual *Ablation*.

Accumulation Zone — The area where the main mass of snow that contributes to an avalanche was deposited originally. Also referred to as the *Accumulation Area*.

Accuracy — A measure of how closely an instrument measures the true or actual value of the process variable being measured or sensed.

Acequia — (Southwestern U.S.) (1) An irrigation canal; an irrigation ditch or channel, a term commonly used in northern New Mexico. (2) A Spanish word used in the Southwestern United States in referring to a community irrigation ditch or canal. (3) Community-run irrigation ditches and/or the community-run organizations that manage them. These systems of water management are rooted in ancient Spanish custom and many still operate in northern New Mexico.

Acicular Ice — Freshwater ice containing air bubbles and having many long, needle-like crystals and hollow tubes in a layered arrangement. Also referred to as *Fibrous Ice* or *Satin Ice*.

Acid — (1) Chemicals that release hydrogen ions (H^+) in solution and produce hydronium ions (H_3O^+). Such solutions have a sour taste, neutralize bases, and conduct electricity. (2) Term applied to water with a pH of less than 7.0 on a pH scale of 0 to 14. (3) Any chemical compound containing hydrogen capable of being replaced by positive elements or radicals to form salts. In terms of the dissociation theory, it is a compound which, on dissociation in solution, yields excess hydrogen ions. Acids lower the pH. Examples of acids or acidic substances are hydrochloric acid, tannic acid, and sodium acid pyrophosphate.

Acid Aerosol — Airborne particles composed of sulfates (SO_x), sulfuric acid (H_2SO_4), nitrates (NO_x), and/or nitric acid (HNO_3). Dry particle diameters are typically less than 1-2 microns. Also see *Acid Deposition* and *Acid Fog*.

Acid Deposition — (1) The input of acid-forming pollutants to a body of water. This situation has caused significant environmental damage in the Northeastern United States. Sulfur and nitrogen pollutants are responsible for most of the *Acidification*. (2) The introduction of acidic material to the ground or to surface waters. Involves a complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then become deposited on the land or surface waters in either wet or dry forms. *Wet Deposition* (commonly referred to as *Acid Rain* or *Acid Fog*) results from precipitation as rain, snow, or fog. *Dry Deposition* results from particle fallout or acidic gases. See *Atmospheric Deposition*.

Acid Fog — Airborne water droplets containing sulfuric acid and/or nitric acid. Typical diameters are 3-30 microns. Also see *Acid Deposition* and *Acid Aerosol*.

Acid-Forming Material — Material containing sulfide minerals or other materials, which if exposed to air, water, or weathering processes will form sulfuric acid that may create *Acid Mine Drainage*.

Acid Mine Drainage (AMD) — (1) Drainage of water from areas that have been mined for coal or other mineral ores; the water has low pH, sometimes less than 2.0, because of its contact with sulfur-bearing material; acid drainage is harmful because it often kills aquatic organisms. (2) Drainage with a strong acidic pH (2-4.5) from mines. Pyrite (FeS_2) in mines is oxidized by oxygen or ferric iron to produce ferrous sulfate and sulfuric acid. At low pH, heavy metals such as iron, magnesium, manganese, copper, zinc, and calcium are more soluble and further pollute the water. (3) Acidic water that flows into streams from abandoned mines or piles of mining waste or tailings. The acid arises from the oxidation of iron sulfide compounds in the mines by air, dissolved oxygen in the water, and chemoautotrophs, which are bacteria that can use the iron sulfide as an energy source. Iron sulfide oxidation products include sulfuric acid, the presence of which has reduced or eliminated aquatic life in many streams in mining regions. Also see *Open-Pit Mining* and *Yellowboy*. Also referred to as *Acid Mine Waste*.

Acid Neutralizing Capacity (ANC) — (1) A measure of the ability of water or soil to resist changes in pH. (2) The equivalent sum of all bases or base-producing materials, *Solutes* plus *Particulates*, in an aqueous system that can be titrated with acid to an equivalence point. The term designates titration of an “unfiltered” sample (formerly reported as *Alkalinity*).

Acid Precipitation — Atmospheric precipitation that is composed of the hydrolyzed by-products from oxidized halogen, nitrogen, and sulfur substances. Also see *Acid Rain*.

Acid Rain — (1) Precipitation which has been rendered (made) acidic by airborne pollutants. (2) Rainfall with a pH of less than 7.0. One of the principle sources is the combining of rain (H_2O) and sulfur dioxide (SO_2), nitrous oxides (NO_x), and carbon dioxide (CO_2) emissions which are byproducts of the combustion of fossil fuels. These oxides react with the water to form sulfuric (H_2SO_4), nitric (HNO_3), and carbonic acids (H_2CO_3). Long-term deposition of these acids is linked to adverse effects on aquatic organisms and plant life in areas with poor neutralizing (buffering) capacity. Also see *Acid Deposition*.

Acid Regression Stage — (Wastewater Treatment) A time period when the production of volatile acids is reduced during *Anaerobic Digestion*. During this stage of digestion of ammonia compounds form and cause the pH to increase.

Acid Soil (Alkaline Soil, Neutral Soil) — A description of one aspect of a soil's chemical composition. Many plants will grow best within a range of pH rating from slightly acid to slightly alkaline. A pH rating of 7 means that the soil is neutral; a pH below 7 indicates acidity; a pH above 7 indicates alkalinity.

Acidic — The condition of water or soil that contains a sufficient amount of acid substances to lower the pH below 7.0.

Acidification — (1) Raising the acidity (i.e., lowering the pH) of a fluid by adding an acid. (2) The result when airborne nitrogen

and sulfur gases (NO_x and SO_x) react with water, oxygen, and other compounds to form sulfuric acid and nitric acid. When NO_x and SO_x (known as acid precursors) reach a water body through dry deposition, they combine with surface water to form nitric acid and sulfuric acid. When these precursors combine with water vapor and oxygen in the atmosphere, they form acids that fall to earth as a component of snow, fog, dry particles, gases or *Acid Rain*. Indirect deposition can occur when these precursors are deposited on land and are then washed into a water body by stormwater runoff. The effects are particularly serious if the storm deposits acid rain.

Acidified — The addition of an acid (usually nitric or sulfuric) to a sample to lower the pH below 2.0. The purpose of acidification is to “fix” a sample so it won't change until it is analyzed.

Acidity — A measure of how acid a solution may be. A solution with a pH of less than 7.0 is considered acidic. Solutions with a pH of less than 4.5 contain mineral acidity (due to strong inorganic acids), while a solution having a pH greater than 8.3 contains no acidity.

Acidity and Alkalinity — Acidity is the concentration of hydrogen ions in a solution, applied usually to solutions having sufficiently high concentrations to exhibit typical acidic characteristics such as sour taste and reactivity with alkalis and certain metals. Weakly acidic solutions (low hydrogen ion concentration) may be typified by vinegar and carbonated water; highly acidic solutions are typified by sulfuric acid and nitric acid. Alkalinity relates to the hydroxyl ion concentration, and to the degree of reactivity with acids. A typical weakly alkaline solution is sodium bicarbonate (baking soda) whereas sodium hydroxide (“lye”) has high alkalinity.

Acidizing — The process of introducing acid into an acid-soluble formation for the purpose of enlarging the pore space by dissolving the surrounding formation, removing encrustants from the well screen and gravel pack, and dissolving cemented materials.

Acidulous Water — Mineral water that contains either dissolved carbonic acid or dissolved sulfur compounds.

Acre — A measure of area equal to 43,560 square feet (4,046.87 square meters). One square mile equals 640 acres, and is also referred to as a *Section*.

Acre-Feet (AF) — A unit commonly used for measuring the volume of water. Plural of *Acre-Foot*.

Acre-Foot (AF) — (1) A unit commonly used for measuring the volume of water; equal to the quantity of water required to cover one acre (43,560 square feet or 4,047 square meters) to a depth of 1 foot (0.30 meter) and equal to 43,560 cubic feet (1,234 cubic meters), or 325,851 gallons. (2) The amount of water needed to cover an acre one foot deep. Typically, an acre-foot can support the annual indoor and outdoor needs of between one and two households per year. Also, on average, 3 to 4 acre-feet are needed to irrigate 1 acre of farmland. By comparison, one acre-foot of water (43,560 square feet covered by 1 foot of water) is nearly enough to cover a football field (45,000 square feet) to a depth of 1 foot.

Acre-Inch — The volume of water or solids that will cover one acre to a depth of one inch, equivalent to 3,630 cubic feet or 102.7 cubic meters.

Act of Nature — A weather event that causes department-approved design capacities for a permitted activity to be exceeded.

Action Level (AL) [EPA] — (1) The concentration of lead or copper in tap water samples which triggers the treatment requirements outlined in the *Lead and Copper Rule [EPA]*. (2) The concentration of lead or copper in water specified at Code of Federal Regulations 141.80(c) which determines, in some cases, the treatment requirements contained in subpart I of this part that a water system is required to complete.

Action Levels — The concentration of a contaminant that, if exceeded, triggers treatment or other requirements which a water utility must follow.

Activated Carbon — (1) Adsorptive particles or granules of carbon usually obtained by heating carbon (such as wood). These particles or granules have a high capacity to selectively remove certain trace and soluble materials from water. (2) A material produced by heating coal or wood in such a manner as to yield a porous structure, creating a very large internal surface area. Activated carbon is available in both powdered and granular forms, and is widely used to adsorb organic compounds from water and wastewater. It provides a means of removing tastes and odors from drinking water. (3) A granular material usually produced by the roasting of cellulose base substances, such as wood or coconut shells, in the absence of air. It has an extremely porous structure and is used in water conditioning as an adsorbent for organic matter and certain dissolved gases. Also see *Granular Activated Carbon (GAC)*. Also referred to as *Activated Charcoal*.

Activated Carbon Adsorption — The process of pollutants moving out of water and attaching on to *Activated Carbon*.

Activated Carbon Filtration — A process used to remove organic chemicals that produce off-taste and odor. These compounds are not dangerous to health but can make the water unpleasant to drink. Carbon filtration comes in several forms, from small filters that attach to sink faucets to large tanks that contain removable cartridges. Activated carbon filters require regular maintenance or they can become a health hazard.

Activated Sludge — (1) A process that removes organic matter from sewage by saturating it with air and biologically active sludge. (2) The *Floc* produced in raw or settled wastewater due to the growth of bacteria and other organisms in the presence of *Dissolved Oxygen*. It is the product that results when primary effluent is mixed with bacteria-laden sludge and then agitated and aerated to promote biological treatment, speeding the breakdown of organic matter in raw sewage undergoing secondary waste treatment.

Activated Sludge Process — (1) A method of *Secondary Wastewater Treatment* in which the waste is treated by microorganisms in a well-aerated tank to degrade the organic material. A sedimentation tank is then used to remove the resultant sludge. (2) A biological wastewater treatment process which speeds up the decomposition of wastes in the wastewater being treated. Activated sludge is added to wastewater and the mixture (mixed liquor) is aerated and agitated. After some time in the aeration tank, the activated sludge is allowed to settle out by sedimentation and is disposed of (wasted) or reused (returned to the aeration tank) as needed. The remaining wastewater then undergoes more treatment.

Active Conservation Storage — (1) Storage of water for later release for purposes, such as municipal and industrial (M&I) uses, hydropower, or irrigation. (2) The portion of water stored in a reservoir that can be released for all useful purposes such as

municipal water supply, power, irrigation, recreation, fish, wildlife, etc. Conservation storage is the volume of water stored between the inactive pool elevation and flood control stage.

Active Fault — A fault that has undergone movement in recent geologic time (the last 10,000 years) and may be subject to future movement. Also see *Fault*.

Active Glacier — (1) A glacier having an accumulation area and exhibiting some degree of ice movement. (2) A relatively rapid-moving glacier in a maritime environment at a low latitude where *Accumulation* and *Ablation* are both great.

Active Layer Thickness — The thickness of the active layer, the zone of annual freezing and thawing above *Permafrost*, determines not only the overall strength of the ground but also many of the physical and biological processes that take place in periglacial terrains. Soil moisture and temperature, lithology and landscape morphology exercise important controls on active layer thickness. Soil moisture and temperature depend largely on climatic factors, so that if the mean annual air temperature rises several degrees Celsius, the thickness of the active layer may change over time periods of years to decades.

Active Solar Water Heater — A water heating system in which heat from the sun is absorbed by collectors and transferred by pumps to a storage unit. The heated fluid in the storage unit conveys its heat to the domestic hot water system of the house through a heat exchanger.

Active Storage Capacity — (1) The total amount of usable reservoir capacity available for seasonal or cyclic water storage. It is gross reservoir capacity minus inactive storage capacity. (2) More specifically, the volume of water in a reservoir below the maximum controllable level and above the minimum controllable level that can be released under gravity. In general, it is the volume of water between the outlet works and the spillway crest. In some instances, *Minimum Pool* operating constraints may prevent lowering the reservoir to the level of the outlet works, and the water below the minimum pool level is not considered to be in active storage.

Active Transport — An energy-expending mechanism by which a cell moves a chemical across the cell membrane from a point of lower concentration to a point of higher concentration, against the diffusion gradient.

Activity — The effective concentration of a chemical based on thermodynamic considerations. Activity and concentration have the same units and have the same value in very dilute solutions.

Acute — (1) Occurring over a short period of time; used to describe brief exposures and effects which appear promptly after exposure. (2) Designates an exposure to a dangerous substance or chemical in sufficient dosage to precipitate a severe reaction. *Acute Exposure* refers to such dosage levels received over a period of 24 hours or less. Longer-term exposures are referred to as *Chronic Exposure*.

Acute Exposure — A single exposure to a toxic substance which results in biological harm or death. Acute exposures are usually characterized as lasting no longer than a day.

Acute Health Effect [EPA] — An immediate (i.e. within hours or days) effect that may result from exposure to certain drinking water contaminants (e.g., *Pathogens*).

Acute Toxicity — The ability of a substance to cause poisonous effects resulting in biological harm or death soon after a single exposure or dose. Also, any severe poisonous effect resulting from a single short-term exposure to a toxic substance.

Adaptation — Changes in an organism's structure or habits that allow it to adjust to its surroundings.

Adaptive Management — A process for implementing policy decisions as an ongoing activity that requires monitoring and adjustment. Adaptive management applies scientific principles and methods to improve resource management incrementally as managers learn from experience and as new scientific findings and social changes demand.

Additive — That which is added, as one substance to another, to alter or improve the general quality, or to counteract undesirable properties.

Additive Effect — Combined effect of two or more chemicals equal to the sum of their individual effects.

Adenosine Triphosphate (ATP) — An organic, phosphate-rich compound important in the transfer of energy in organisms. Its central role in living cells makes it an excellent indicator of the presence of living material in water. A measure of ATP therefore provides a sensitive and rapid estimate of *Biomass*. ATP is reported in micrograms per liter of the original water sample.

Adequate-Size Farm — A farm with resources and productivity sufficient to generate enough income to (a) provide an acceptable level of family living; (b) pay current operating expenses and interest on loans; and (c) allow for capital growth to keep pace with technological growth.

Adequate Well — A well constructed or rehabilitated to allow various withdrawal methods to be used, to allow the inlet to the pump to be placed not less than a specified distance into the saturated aquifer or formation material when the well is constructed, or to allow the pump to be placed as near to the bottom of the aquifer as is practical if the aquifer thickness is less than a certain width.

Adfluvial — Migrating between lakes and rivers or streams; typically used of fish species.

Adhesion — Molecular attraction that holds the surfaces of two substances in contact, such as water and rock particles. Also, the attraction of water molecules to other materials as a result of hydrogen bonding.

Adhesive Water — See *Pellicular Water*.

Adiabatic — (1) Occurring without transfer of heat, i.e., with neither addition nor removal of heat to or from the system involved. Adiabatic differences in atmospheric temperature are those dependent on pressure changes with elevation. (2) Applies to a thermodynamic process during which no heat is added to or withdrawn from the body or system concerned. In the atmosphere, adiabatic changes of temperature occur only in consequence of compression or expansion accompanying an increase or decrease of atmospheric pressure. Thus, a descending body of air undergoes compression and adiabatic cooling.

Adiabatic Lapse Rate — The theoretical rate at which the temperature of the air changes with altitude. The temperature change is due to the pressure drop and gas expansion only, and no heat is considered to be exchanged with the surrounding air through convection or mixing. The *Dry Adiabatic Lapse Rate* for air not saturated with water vapor is 0.98°Celsius per 100 meters

(5.4°Fahrenheit per 1,000 feet). The *Wet Adiabatic Lapse Rate* for air saturated with water vapor is about 0.60°F per 100 meters (3.3°F per 1,000 feet).

Adiabatic Process — A change involving no gain or loss of heat.

Adirondack Type Snow Sampling Set — (Climatology) A snow sampler consisting of a 5-foot fiberglass tube, 3 inches in diameter, with a serrated-edge steel cutter at one end and a twisting handle at the other. This sampler has a 60-inch snow depth capacity.

Adit — A horizontal or nearly horizontal passage, driven from the surface, for the working or dewatering of a mine. Also referred to as *Drift*, *Shaft*, or *Portal*.

Adjacent Wetlands [United States, 33 CFR 328.3(c)] — The term “adjacent” means bordering, contiguous, or neighboring. Therefore, wetlands separated from other Waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are defined as “adjacent wetlands.”

Adjudicate — To determine judicially or by judicial action.

Adjudication — (1) Refers to a judicial process whereby water rights are determined or decreed by a court of law. (2) A court proceeding to determine all rights to the use of water on a particular stream system or within a specific groundwater basin.

Administered Groundwater Basin — A groundwater basin (watershed, area, or sub-area) which, in the interest of public welfare, is monitored by an appropriate agency to insure adequate water resources for prescribed uses. Quite often, such basins will have *Preferred Uses* designated for future development to insure that the basin’s *Perennial Yield* is not exceeded. Also referred to as *Designated Groundwater Basin*. Also see *Designated Groundwater Basin [Nevada]*.

Adolescent — (1) Describing a river or stream having a well-cut, smoothly graded channel that may reach base level at its mouth. (2) (Geology) Of or relating to the stage in the erosion cycle between youth and maturity, for example, an adolescent river or an adolescent stream.

Adsorbate — (1) The material being removed by the adsorption process. (2) Any material adsorbed onto the surface of another.

Adsorbent — (1) The material (activated carbon) that is responsible for removing the undesirable substance in the adsorption process. (2) Any material which adsorbs another on its surface.

Adsorber — A solid or liquid that can hold molecules of another substance on its surface.

Adsorption — (1) The process by which chemicals are held on the surface of a mineral or soil particle (contrast with *Absorption*). (2) The adherence of ions or molecules in solution to the surface of solids. (3) The adherence of a gas, liquid, or dissolved material on the surface of a solid. (4) The attraction and adhesion of a layer of ions from an aqueous solution to the solid mineral surfaces with which it is in contact. An example is the adsorption of organic materials by activated carbon.

Adtidal — (Ecology) Relating to an organism living immediately below low tide level.

Advance — (1) The forward, downslope movement of a *Glacier*, which occurs when accumulation exceeds ablation. (2) A time interval that is delineated by the general expansion of a glacier.

Advanced Treatment — A level of wastewater treatment more stringent than secondary treatment; requires an 85 percent reduction in conventional pollutant concentration or a significant reduction in nonconventional pollutants.

Advanced Wastewater Treatment (AWT) — (1) Any process which reduces the level of impurities in a wastewater below that attainable through conventional secondary or biological treatment. Includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids. (2) Any process of water renovation that upgrades treated wastewater to meet specific reuse requirements. May include general cleanup of water or removal of specific parts of wastes insufficiently removed by conventional treatment processes. Typical processes include chemical treatment and pressure filtration. Also called *Tertiary Treatment*.

Advance Time — The time it takes for water to travel the length of an irrigation furrow.

Advection — (1) The process by which solutes are transported by the bulk of flowing fluid such as the flowing . (2) The horizontal transfer of heat energy by large-scale motions of the atmosphere.

Advection Fog — A type of fog caused by the advection of moist air over a cold surface, and the consequent cooling of that air to below its *Dew Point*.

Adverse Effect [USFS] — (Ecology) An action that has an apparent direct or indirect negative effect on the conservation and recovery of an ecosystem component listed as *Threatened* or *Endangered*.

Adversely Impacted Domestic Well — A well in which the pump intake was set at least a specified distance below the top of the aquifer at the time of construction or, if the aquifer is less than the specified distance thick, is as near to the bottom of the aquifer as is practical and the water level of the aquifer has declined to a level that the pump will no longer deliver sufficient water for the well owner’s needs.

(Weather) Advisory [NWS] — A product issued by the *National Weather Service (NWS)* indicating that the associated condition (e.g., snow, freezing rain, winter weather, dense fog, heat, urban and small stream flood, etc.) is imminent or occurring, but is not life threatening when caution and common sense are exercised. Also see *Warning [NWS]* and *Watch [NWS]*. Some of the more common weather advisories issued by the NWS include:

- [1] **Blowing Snow Advisory** – Issued when wind-driven snow (old or new) reduces visibility enough to hamper travel;
- [2] **Dense Fog Advisory** – Issued when widespread fog with visibilities of ¼-mile (about 400 meters) or less are imminent or occurring;
- [3] **Freeze Advisory** – Issued during the growing season when temperatures over a large area are forecast to fall well below freezing;
- [4] **Freezing Rain or Drizzle Advisory** – Issued when the intensity of freezing rain or freezing drizzle is light and ice does not form on all exposed surfaces;
- [5] **Frost Advisory** – Issued during the growing season when the formation of widespread frost is forecast to occur;
- [6] **Snow Advisory** – Issued when snowfall is expected to accumulate between 3 and 5 inches (8 and 13 cm), or for 1

or 2 inch (2.5 or 5 cm) snowfalls at the beginning of the snow season. These criteria are specific for the Midwestern United States and may vary regionally;

- [7] **Urban and/or Small Stream Flood Advisory** – Issued when localized flooding which is an inconvenience or nuisance (not life threatening) to people living in the affected area. This includes flooding of streets and roads, urban storm drains, low-lying areas and small creeks and streams;
- [8] **Wind Advisory** – Issued when sustained winds of 30 mph (13 meters/second) or greater are expected to last for 1 hour or longer, or gusts to 45 mph (20 meters/second) or higher are expected for any duration. These criteria are specific for the Midwest and may vary regionally;
- [9] **Wind Chill Advisory** – Issued when wind chill factors of -35EF (-37EC) or colder for a sustained period of time are imminent or occurring; and
- [10] **Winter Weather Advisory** – Issued when a mixture of precipitation such as snow, sleet, freezing rain or drizzle is imminent or occurring.

Aedile — An elected official of ancient Rome who was responsible for public works and games and who supervised markets, the grain supply, and the water supply.

Aeolian Soil — Soil transported from one area to another by the wind.

Aerate — To supply or charge a liquid or body of water with a gas, as to expose a body of water to the circulation of air for purification. See *Aerated Lagoon*.

Aerated Lagoon — A holding and/or treatment pond that speeds up the natural process of biological decomposition of organic waste by stimulating the growth and activity of bacteria that degrade organic waste.

Aeration — (1) The process of adding air to water. Air can be added to water by either passing air through water or passing water through air. (2) Any active or passive process by which intimate contact between air and liquid is assured, generally by spraying liquid in the air, bubbling air through water, or mechanical agitation of the liquid to promote surface absorption of air. The process of bringing air into intimate contact with water, usually by bubbling air through the water to remove dissolved gases like carbon dioxide and hydrogen sulfide or to oxidize dissolved materials like iron compounds. (3) The process of loosening or puncturing the soil by mechanical means in order to increase water and air permeability.

Aeration Tank — A chamber used to inject air into water.

Aeration (Unsaturated) Zone — (1) The zone between the land surface and the water table which characteristically contains liquid water under less than atmospheric pressure and water vapor and air or other gases at atmospheric pressure. (2) A portion of the *Lithosphere* in which the functional interstices of permeable rock or earth are not filled with water under hydrostatic pressure. The interstices either are not filled with water or are filled with water that is not held by capillarity. The term *Unsaturated Zone* is now generally applied.

Aerobe — An organism which requires oxygen for its life processes.

Aerobic — (1) A condition in which free (atmospheric) or dissolved oxygen is present in the water. (2) Pertaining to organisms which live or are active only in the presence of oxygen. (3) Characterizing organisms able to live only in the presence of air or free oxygen, and conditions that exist only in the presence of air or free oxygen. Contrast with *Anaerobic*.

Aerobic Bacteria — (1) Single-celled, microscopic organisms that require oxygen to live and are partly responsible for the *Aerobic Decomposition* of organic wastes. (2) Bacteria which will live and reproduce only in an environment containing oxygen which is available for their respiration (breathing), namely atmospheric oxygen or oxygen dissolved in water. Oxygen combined chemically, such as in water molecules (H₂O), cannot be used for respiration by aerobic bacteria.

Aerobic Decomposition — The biodegradation of materials by aerobic microorganisms resulting in the production of carbon dioxide, water, and other mineral products. Generally a faster process than *Anaerobic Decomposition*. Also see *Aerobic Bacteria*.

Aerobic Digestion — (Wastewater Treatment) The breakdown of wastes by microorganisms in the presence of dissolved oxygen. This digestion process may be used to treat only waste activated sludge, or trickling filter sludge and primary (raw) sludge, or waste sludge from activated sludge treatment plants designed without primary settling. The sludge to be treated is placed in a large aerated tank where aerobic microorganisms decompose the organic matter in the sludge. This is an extension of the activated sludge process.

Aerobic Treatment — The process by which microbes decompose complex organic compounds in the presence of oxygen and use the liberated energy for reproduction and growth. Such processes may include extended aeration, trickling filtration, and rotating biological contactors.

Aerobic Treatment Unit (ATU) — Also known as home aeration units, the aerobic treatment unit, or ATU, provides wastewater treatment and storage functions similar to a normal septic tank. By contrast, however, the ATU has a mechanism to inject air into the tank, thereby turning the anaerobic environment aerobic. This allows aerobic bacteria to treat the wastewater resulting in a cleaner effluent than that from a normal septic tank system. The basic ATU consists of an aeration chamber and a settling chamber, with some ATUs also having pretreatment chambers and/or screens to reduce the amount of larger solids entering the aeration chamber. The aeration chamber contains a mechanical stirrer or diffuser lines to add air to the wastewater. Aerated wastewater treatment is more effective and produces a better quality effluent than anaerobic or septic treatment. The improved effluent quality allows ATUs to be used on sites that are not suitable for conventional septic systems.

Aerodynamic — Refers to forces acting upon the soil or crop surface by moving air.

Aeroponics — A technique for growing plants without soil or hydroponic media. The plants are held above a system that constantly mists the roots with nutrient-laden water. Also called *Aeroculture*.

Aerosol — A suspension of liquid or solid particles in air or gas.

AF — Abbreviation for *Acre Foot*. Also see *Total Alkalinity Factor*.

Affected Environment — (1) Existing biological, physical, social and economic conditions of an area are subject to change, both directly

and indirectly, as the result of a proposed human action. (2) The chapter in an Environmental Impact Statement (EIS) describing current environmental conditions.

Affected Public — The people who live and/or work near a hazardous waste site or other source of pollutant emissions.

Affluent (Lake) — A tributary or feeder stream. Streams receiving the run-off from the watershed and flowing into the lake are its affluents; analogous to the affluent of a river. The analogy can be very close where a lake has large inflowing and outflowing streams and is located in a valley or elongated basin. In usage, the term may have the same meaning as influent; although where the reference is to a single inflowing stream, the word influent appears to be the preferred one. Also see *Influent* and *Inlet*.

Affluent (Stream) — A stream or river that flows into a larger one; a *Tributary*.

Afforestation — The artificial establishment of forest crops by planting or sowing on land that has not previously, or recently, grown trees.

Afterbay — The tail race or reservoir of a hydroelectric power plant or a pumping plant at the outlet of the turbines used to regulate the flow below the plant; may refer to a short stretch of stream or conduit, or to a pond or reservoir. Compare with *Forebay*.

AFY (afy) — Acre-foot per year.

Age (of Groundwater) — An approximation of the time between the water's penetration of the land surface at one location and its later presence at another location.

Age Tank — A tank used to store a chemical solution of known concentration for feed to a chemical feeder. Also called a *Day Tank*.

Agglomerate — An ice cover of floe formed by the freezing together of various forms of ice.

Agglomeration — (Water Quality) The grouping of small suspended particles into larger particles that are more easily removed through filtration, skimming, or settling. Also see *Coagulation*.

Aggradation — (1) The raising of stream beds or flood plains by deposition of sediment eroded and transported from upstream. (2) The build-up of sediments at the headwaters of a lake or reservoir or at a point where streamflow slows to the point that it will drop part or all of its sediment load. (3) The building of a floodplain by sediment deposition; the filling of a depression or drainageway with sediment; the building of a fan by deposition of an alluvial mantle. (4) Modification of the earth's surface in the direction of uniformity of grade or slope, by *Deposition*, as in a river bed. (5) The growth or spread of *Permafrost* under present climatic conditions. Opposite of *Degradation*. Also see *Accretion*.

Aggrade — The raising of a stream-channel bed with time due to the *Deposition* of sediment that was eroded and transported from the upstream watershed or the channel.

Aggrading — The building up of a stream channel which is flowing too slowly to carry its sediment load.

Aggregate — A mass or cluster of soil particles, often having a characteristic shape.

Aggregation — Formation of aggregates. In drilling fluids, aggregation results in the stacking of the clay platelets face to face, as a result, viscosity and gel strength decrease.

Aggressive Water — Water which is soft and acidic and can corrode plumbing, piping, and appliances.

Agitated Pit — A reservoir, pit, or pond that ordinarily is not stirred or aerated, but which is mixed just before emptying to suspend any settled solids.

Agitator/Mixer — (Water Quality) Blades or paddles that slowly rotate in a tank to facilitate the mixing of suspended material.

Agribusiness — The sum of all operations involved in the production, storage, processing, and wholesale marketing of agricultural products.

Agricultural Drainage — (1) The process of directing excess water away from the root zones of plants by natural or artificial means, such as by using a system of pipes and drains placed below ground surface level. Also referred to as *Subsurface Drainage*. (2) The water drained away from irrigated farmland.

Agricultural Drought — A general form of drought which occurs when soil moisture availability to agricultural crops is reduced to a level causing adverse effects on grain yield and consequently, the agricultural production of a region. Compare to *Hydrological Drought* and *Meteorological Drought*.

Agricultural Economics — The application of economic principles to the *Agribusiness* sector of the economy.

Agricultural Land — Land in farms regularly used for agricultural production; all land devoted to crop or livestock enterprises, for example, farmstead lands, drainage and irrigation ditches, water supply, cropland, and grazing land.

Agricultural Levee — A levee that protects agricultural areas where the degree of protection is usually less than that of a flood control levee.

Agricultural Pollution — Liquid and solid wastes from all types of farming, including runoff from pesticides, fertilizers, and feedlots; erosion and dust from plowing; animal manure and carcasses; and crop residues and debris. Agriculture is generally recognized as the leading nonpoint source of water pollutants, such as sediments, nutrients, and pesticides. Among other water pollution problems related to agriculture, nitrate pollution has been of growing concern. Nitrate contamination from agricultural activities has been reported in almost every state in the United States.

Agricultural Restructuring Scenario (ARS) — A term used to describe the sensitivity of agricultural water demand and farm marketing revenues to changes in certain cropping patterns.

Agricultural Runoff — The runoff into surface waters of herbicides, fungicides, insecticides, and the nitrate and phosphate components of fertilizers and animal wastes from agricultural land and operations. Considered a *Non-Point Source (NPS)* of water pollution.

Agricultural Use — The use of any tract of land for the production of animal or vegetable life; uses include, but are not limited to, the pasturing, grazing, and watering of livestock and the cropping, cultivation, and harvesting of plants.

Agricultural Water Use (Withdrawals) — Includes water used for irrigation and non-irrigation purposes. Irrigation water use includes the artificial application of water on lands to promote the growth of crops and pasture, or to maintain vegetative growth in recreational lands, parks, and golf courses. Non-irrigation water use includes water used for livestock, which includes water

for stock watering, feedlots, and dairy operations, and fish farming and other farm needs.

Agro-Ecosystem — Land used for crops, pasture, and livestock; the adjacent uncultivated land that supports other vegetation and wildlife; and the associated atmosphere, the underlying soils, ground and surface waters, irrigation channels, and drainage networks.

Agrochemical — Synthetic chemicals (e.g., pesticide and fertilizers) used in agricultural production.

Agroindustrial — Of or relating to production (as of power for industry and water for irrigation) for both industrial and agricultural purposes.

Agronomic Rates — Sludge application rates which provide the amount of nitrogen needed by the crop or vegetation grown on the land while minimizing the amount that passes below the root zone.

Aground — Onto or on a shore, reef, or the bottom of a body of water.

Air — The colorless, odorless, tasteless, gaseous mixture that makes up the earth's *Atmosphere*. Four gases comprise 99.997 percent (by volume) of clean, dry, air: *Nitrogen* (78.084 percent); *Oxygen* (20.946 percent); *Argon* (0.934 percent); and *Carbon Dioxide* (0.033 percent). The remaining components include neon, helium, methane, krypton, nitrous oxide, hydrogen, xenon, and various organic vapors. Under normal conditions, air contains up to about 3 percent water vapor (by volume) and many solid, liquid, or gaseous contaminants introduced by human activities and natural causes such as wind erosion and the burning of fossil fuels.

Air Binding — A situation where air enters the filter media. Air is harmful to both the filtration and backwash processes. Air can prevent the passage of water during the filtration process and can cause the loss of filter media during the backwash process.

Air-Bound — Condition in a pipeline wherein air trapped in a summit prevents the free flow of the material in the pipeline.

Air Curtain — A method for mechanical containment of oils spills in which air is bubbled through a perforated pipe, causing an upward water flow that retards the spreading of oil; also used as barriers to prevent fish from entering a polluted body of water.

Air Gap — An open vertical drop, or vertical empty space, that separates a drinking (potable) water supply from a non potable source. This open gap prevents the contamination of drinking water from *Backsiphonage* or *Backflow* because the non-potable material is not in physical contact with the potable water system.

Air Hole — An opening in the frozen surface of a body of water.

Air Injection — In groundwater management, the pumping of compressed air into the soil to move water in the *Unsaturated Zone* (*Vadose Zone*) down to the *Saturated Zone* (*Phreatic Zone*), or *Water Table*.

Air Lift — (Wastewater Treatment) A special type of pump which consists of a vertical riser pipe submerged in the wastewater or sludge to be pumped. Compressed air is injected into a tail piece at the bottom of the pipe. Fine air bubbles mix with the wastewater or sludge to form a mixture lighter than the surrounding water which causes the mixture to rise in the discharge pipe to the outlet. An air lift pump works like the center stand in a percolator coffee pot.

Air Lock — A bubble or pocket of air or vapor, as in a pipe, that stops the normal flow of fluid through the conducting part.

Air Mass — A large body of air of considerable depth which is approximately homogeneous horizontally. At the same level, it has nearly uniform physical properties, especially as regards to temperature and moisture.

Air Padding — Pumping dry air into a container to assist with the withdrawal of liquid or to force a liquefied gas such as chlorine out of the container.

Air Pollutant — An air pollutant is any substance in the air which causes damage to life, ecosystems or property. Air pollution arises mostly from human activity, but there are also natural sources such as volcanoes and forest fires. Since airborne pollutants can travel very long distances, identifying sources to a body of water can be very complicated. There are five categories of air pollutants with the greatest potential to harm water quality: (a) nitrogen; (b) mercury; (c) other metals; (d) combustion emissions; and (e) pesticides. These pollutants all have the ability to settle into bodies of water and damage ecosystems as well as public health. Once pollutants become airborne, they may fall to the ground in a process called *Atmospheric Deposition*. The deposition of an air pollutant on land or water can take several forms. For example, wet deposition occurs when air pollutants fall with rain, snow, or fog. Dry deposition is the deposition of pollutants as dry particles or gases. The pollutants can reach bodies of water as direct deposition falling directly into the water, or as indirect deposition, falling onto land and washing into a body of water as runoff.

Air Stripping — (Water Quality) (1) A mass transfer process in which a substance in solution in water is transferred to solution in a gas, usually air. (2) A process for the removal of organic contaminants from groundwater. The groundwater flows downward inside a tower filled with materials (the packing) over a large surface area. Air is introduced at the bottom of the tower and is forced upward past the falling water. Individual organic contaminants are transferred from the water to the air, according to the gas and water equilibrium concentration values of each contaminant. Also referred to as *Packed Tower Aeration*.

Air Vent (of a Dam) — A pipe designed to provide air to the outlet conduit to reduce turbulence and prevent negative pressures during the release of water. Extra air is usually necessary downstream of constrictions.

Airborne Snow Survey Program — (Climatology) A *National Operational Hydrologic Remote Sensing Center (NOHRSC)* program that makes airborne snow water equivalent and soil moisture measurements over large areas of the country that are subject to severe and chronic snowmelt flooding.

Airborne Snow Water Equivalent Measurement Theory [NWS] — A theory based on the fact that natural terrestrial gamma radiation is emitted from the potassium, uranium, and thorium radioisotopes in the upper eight inches of the soil. The radiation is sensed from low flying aircraft 500 feet above the ground. Water mass in the snow cover attenuates the terrestrial radiation signal. The difference between airborne radiation measurements made over bare ground and snow-covered ground can be used to calculate a mean areal snow water equivalent value with a root mean square error of less than a half inch.

Airshed — An airshed is the geographic area responsible for emitting 75 percent of the air pollution reaching a body of water. Since different pollutants behave differently in the atmosphere, the aerial extent of an airshed of a given body of water may vary depending on the pollutant of interest. While watersheds are actual physical features of the landscape, airsheds are determined

using mathematical models of *Atmospheric Deposition*. Airsheds are very useful in explaining the transportation of pollutants and can help manage a body of water much more effectively.

Aktology — (Ecology) The study of the conditions, sediments, or life of inshore or shallow water areas. Derivative term includes *Aktological*.

Alachlor — A herbicide, marketed under the trade name Lasso, listed by the *U.S. Environmental Protection Agency (EPA)* as a “probable human carcinogen” and found frequently in streams and rivers, particularly following floods and periods of heavy rain. Alachlor is used extensively for weed control in corn, cotton, and soybean fields.

Aldosterone — A steroid hormone secreted by the adrenal cortex that regulates the salt and water balance in the human body.

Alfalfa Valve — A screw-type valve placed on the end of a pipe to regulate the flow of water.

Algae — (1) Microscopic plants that are free-living and usually live in water. They occur as single cells floating in water, or as multicellular plants like seaweed or strands of algae that attached to rocks. (2) Simple single-celled, colonial, or multi-celled, mostly aquatic plants, containing chlorophyll and lacking roots, stems and leaves. Aquatic algae are microscopic plants that grow in sunlit water that contains phosphates, nitrates, and other nutrients. Algae, like all aquatic plants, add oxygen to the water and are important in the fish food chain. (3) Any of several motile or nonmotile, chlorophyll-containing plants of the phylum *Thallophyta*, ranging from unicellular, usually microscopic forms to multicellular forms sometimes 100 feet or more in length. Occurs in fresh or salt water, or in or on other organisms, or soil, rocks, trees, etc. Characterized by green color. Proliferates in polluted water.

Algal Bloom — (1) Rapid growth of algae on the surface of lakes, streams, or ponds; stimulated by nutrient enrichment. (2) Population explosion of algae in surface waters due to an increase in plant nutrients (such as nitrates and phosphates), temperature, or both. (3) A heavy growth of algae in and on a body of water as a result of high phosphate concentration such as from farm fertilizers and detergents. (4) A rapid and noticeable increase in the amount of algae in a body of water. Algae, sometimes called phytoplankton, are microscopic, single-celled plants that are the basis of aquatic ecosystems. Algal blooms occur naturally, but increased inputs of nitrogen or phosphorous to a body of water can cause massive blooms that harm the ecosystem. It is associated with *Eutrophication* and results in a deterioration in water quality. Also spelled *Algae Bloom*.

Algal Growth Potential (AGP) — The maximum algal dry weight biomass produced in a natural water sample under laboratory conditions. Expressed as milligrams (mg), dry weight per liter (l) of sample.

Algal Growth Rate — A measure of algal productivity in a body of water, the growth rate measures the mass of carbon used annually by algae per unit area of lake surface. The growth rate, typically referred to as *Primary Productivity*, is expressed as an index figure in grams of carbon per square meter per year, and indicates the state of *Eutrophication* of a body of water. Algal productivity is influenced by the quantities of nutrients that flow into, or fall onto, the lake each year and the number of days of sunshine. Another important factor is the mixing of the lake, which brings up to the surface where algae exist nutrients which have accumulated near the bottom of the lake.

Algicide — One of a group of plant poisons used to kill filamentous algae and phytoplankton.

Algorithm — A series of well-defined steps used in carrying out a specific process. May be in the form of a word description, an explanatory note, a diagram or labeled flow chart, or a series of mathematical equations.

Alkali — Any strongly basic (high pH) substance capable of neutralizing an acid, such as soda, potash, etc., that is soluble in water and increases the pH of a solution greater than 7.0. Also refers to soluble salts in soil, surface water, or groundwater.

Alkali Lakes — Also referred to as “soda lakes;” natural bodies of water characterized by high pH (i.e., pH = 10) and a high concentration of salts.

Alkaline — (1) Any of various soluble mineral salts found in natural water and soils having a pH greater than 7. In water analysis, it represents the carbonates, bicarbonates, hydroxides, and occasionally the borates, silicates, and phosphates in the water. (2) Sometimes water or soils contain an amount of *Alkali* substances sufficient to raise the pH value above 7.0 and be harmful to the growth of crops. Generally, the term alkaline is applied to water with a pH greater than 7.4.

Alkalinity — (1) Refers to the extent to which water or soils contain soluble mineral salts. Waters with a pH greater than 7.4 are considered alkaline. (2) The capacity of water for neutralizing an acid solution. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates, carbonates and occasionally borates, silicates and phosphates. It is expressed in units of milligrams per liter (mg/l) of CaCO₃ (calcium carbonate). A solution having a pH below 4.5 contains no alkalinity.

Alkyl Benzene Sulfonate (ABS) — A type of surfactant, or surface active agent, present in synthetic detergents in the United States before 1965. ABS was especially troublesome because it caused foaming and resisted breakdown by biological treatment processes. ABS has been replaced in detergents by *Linear Alkyl Sulfonate (LAS)* which is biodegradable.

Allochthonous Material — Organic material that falls into a stream from the surrounding land. Compare to *Autochthonous Material*.

Allochthonous Stream — A stream that is flowing in a channel it did not itself form.

Allogenic — Exogenous, caused by external factors, such as a change in a habitat or environment caused by flooding. Contrast with *Autogenic*.

Allogenic Succession — Predictable changes in plant and animal communities in which changes are caused by events external to the community, for example, fire, drought, floods, etc.

Allelopathy — An interaction between plant species in which one species inhibits the establishment or growth on the second species through production of a selectively inhibitory chemical agent.

Allotrophic Lake — (Ecology) A lake that receives organic material by drainage from the surrounding land.

Alluvial — (1) Pertaining to processes or materials associated with transportation or deposition by running water. (2) Pertaining to material carried or laid down by running water. *Alluvium* is the material deposited by streams and typically includes gravel, sand, silt, and clay. (3) An adjective referring to soil or earth material which has been deposited by running water, as in a riverbed,

flood plain, or delta.

Alluvial Dam — (Geology) A sedimentary deposit built up by an overloaded stream and obstructing the stream channel.

Alluvial Dam Lakes — Numerous basins which are the sites of both existing and extinct lakes in the arid regions of western U. S. which were formed by alluvial dams, especially by the coalescence of fans composed of detritus carried down by streams from opposite sides of valleys. In glaciated regions, dams were formed in valleys by glacio-fluvial deposition during the *Pleistocene Epoch*; and barriers of various kinds, which impound water have been created in river flood plains by alluvial deposition. See *Fluviatile Lakes* and *Levee Lakes*.

Alluvial Fan — (1) A fan-shaped deposit of generally coarse material created where a stream flows out onto a gentle plain; a geomorphologic feature characterized by a cone or fan-shaped deposit of clay, silt, sand, gravel, and boulders that have been eroded from mountain slopes, transported by flood flows, and deposited on the valley floor. (2) A geomorphologic feature characterized by a cone or fan-shaped deposit of boulders, gravel, and fine sediments that have been eroded from mountain slopes, transported by flood flows, and then deposited on the valley floors, and which is subject to flash flooding, high velocity flows, debris flows, erosion, sediment movement and deposition, and channel migration. (3) (Montane) A semiconical, or fan-shaped constructional, major landform that is built of more-or-less stratified alluvium with or without debris flow deposits, that occurs on the upper margin of a piedmont slope, and that has its apex at a point source of alluvium debauching from a mountain valley into an inter-montane basin. Also, a generic term for like forms in various other landscapes.

Alluvial Fan Flooding — Flooding occurring on the surface of an *Alluvial Fan* or similar landform which originates at the apex and is characterized by high-velocity flows, active processes of erosion, sediment transport, deposition, and unpredictable flow paths.

Alluvial Flat — A nearly level, graded, alluvial surface between the piedmont slope and playa of a *Bolson* or the axial-stream floodplain of a semi-bolson. This major landform may include both recent and relict components.

Alluvial Land — Areas of unconsolidated alluvium, generally stratified and varying widely in texture, recently deposited by streams, and subject to frequent flooding.

Alluvial Plain — (1) A level or gently sloping tract or a slightly undulating land surface produced by extensive deposition of *Alluvium*, usually adjacent to a river that periodically overflows its banks; it may be situated on a *Flood Plain*, a delta, or an *Alluvial Fan*. (2) A major landform of some basin floors, comprised of the floodplain of a major Pleistocene stream that crossed the floor, or of a low gradient fan-delta built by such a stream. It is distinguished from an alluvial flat by its relatively well sorted and stratified alluvium.

Alluvial Terrace — (Geology) A terraced embankment of loose, unconsolidated alluvial material that is built up adjacent to the sides of a river valley. Also referred to as a *Built Terrace*, *Drift Terrace*, or *Fill Terrace*.

Alluvial Valley Floor — [Public Law 95–87, Section 701] (Legal) “The unconsolidated stream laid deposits where water availability is sufficient for subirrigation or flood irrigation. It does not include upland areas which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits by unconcentrated runoff or slopewash, talus, or other mass movement accumulation and wind-blown deposits.”

Alluviation — The deposition or formation of *Alluvial* sediments or features along the course of a river or stream.

Alluvion — (1) The flow of water against a shore or bank. Inundation by water; flood. (2) (Legal) The increasing of land area along a shore by deposited *Alluvium* or by the recession of water.

Alluvium — (1) A general term for all sediment deposited in land environments by streams. A stratified bed of sand, gravel, silt, and clay deposited by flowing water. (2) A general term for deposits of clay, silt, sand, gravel, or other particulate material that has been deposited by a stream or other body of running water in a streambed, on a flood plain, on a delta, or at the base of a mountain. (3) A general term for such unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or its flood plain or delta, or as a cone or fan at the base of a mountain slope; especially such a deposit of fine-grained texture (silt or silty clay) deposited during time of flood. Also see *Alluvion*.

Alpenglow — A rosy glow that suffuses snow-covered mountain peaks at dawn or dusk on a clear day.

Alpha and Beta Radioactivity — Represent two common forms of radioactive decay. Radioactive elements have atomic nuclei so heavy that the nucleus will break apart, or disintegrate spontaneously. When decay occurs, high-energy particles are released. These high-energy particles are called radioactivity. Although radioactivity from refined radioactive elements can be dangerous, it is rare to find dangerous levels of radioactivity in natural waters. An alpha particle is a doubly-charged helium nucleus comprised of two protons, two neutrons, and not electrons. A beta particle is a high-speed electron. Alpha particles do not penetrate matter easily, and are stopped by a piece of paper. Beta particles are much more penetrating and can pass through a millimeter of lead.

Alpha Particle — A type of particle involved in radioactivity which is identical with the nucleus of an atom of helium, consisting of 2 protons and 2 neutrons and therefore having a double positive charge.

Alpine — That portion of mountains above tree growth; or organisms living there.

Alpine Decree [California and Nevada] — The Federal Court adjudication of the relative water rights on the Carson River which is the primary regulatory control of Carson River operations today. The decree is administered in the field by a *Watermaster* appointed by the federal district court. The decree, initiated by the U.S. Department of the Interior on May 1, 1925 through *United States of America v. Alpine Land and Reservoir Company, et al.*, Civ. No. D-183 BRT, to adjudicate water rights along the Carson River. The decree was finally entered 55 years later on October 28, 1980, making it the longest lawsuit undertaken by the federal government against private parties over water rights. The decree established the respective water rights (to surface water only) of the parties to the original lawsuit, both in California and Nevada to Carson River water. The decree did not make an interstate allocation of the Carson River between California and Nevada; it only quantified individual water rights. Neither state was a party to the decree. In addition to Carson River surface water rights, it also established the rights to reservoir storage

in the high alpine reservoirs and confirmed the historical practice of operating the river on rotation, so that irrigators with more junior priorities could be served as long as possible. These upper alpine reservoirs were permitted to fill out of priority order, in accordance with historical practice. The decree also specifically recognized *Riparian Water Rights* in California (as distinguished from the quantified *Appropriative Water Rights* used in Nevada). For purposes of water distribution, the Carson River and its east and west forks, were divided into eight (8) segments and when the river went into regulation (i.e., there was not enough water in the Upper Carson River to serve the most junior priority) each segment of the river was to be administered autonomously. Duties of water were set forth for various locations according to *Bench Land* and *Bottom Land* designations. For lands in the *Newlands Irrigation Project* (i.e., below Lahontan Dam) in Churchill County near Fallon, the Alpine decree provided for an annual net consumptive use of surface water for irrigation of 2.99 acre-feet per acre and a maximum water duty of 4.5 acre-feet per acre for water-righted bench lands and 3.5 acre-feet per acre for water-righted bottom lands *delivered to the land*. For lands above the Newlands Project (i.e., above Lahontan Reservoir), the net consumptive water use was set at 2.5 acre-feet per acre with water duties of 4.5 acre-feet per acre *diverted to the canal* for bottom lands, 6.0 acre-feet per acre diverted to the canal for the alluvial fan lands and 9.0 acre-feet per acre diverted to the canal for the bench lands. This annual net consumptive use, or *Crop Water Requirement*, was based on the water duty of alfalfa as it is a dominant and the highest water-using crop grown in Nevada. While the Alpine Decree established water duties for bench and bottom lands throughout the Carson River Basin, it made no identification of those lands. The decree also granted landowners on the Newlands Project an *Appurtenant Water Right* for the patented lands, effectively transferring water rights to these land holders individually.

Alpine Glacier — A moving mass of ice that accumulates in a previously formed mountain stream valley; a snow catchment area. This alpine glacial erosion creates a rugged, sharp topography with U-shaped valleys; characteristics include horns, moraines, cirques, and aretes. Also referred to as a *Mountain Glacier* or *Valley Glacier*.

Alternate Concentration Limits (ACLs) — One of the three types of standards that may be applied when a leak is detected at a treatment, storage, or disposal facility and groundwater compliance monitoring is required. ACLs are set by the *U.S. Environmental Protection Agency (EPA)* for specific hazardous waste constituents at levels that are designed to prevent a substantial hazard to human health or the environment. Groundwater compliance monitoring can use the following standards: (1) background concentrations, or the levels found in the area naturally; (2) specific values set by federal regulations in Title 40, Part 264.94, of the *Code of Federal Regulations* for eight metals and six pesticides and herbicides; or (3) alternative concentration limits.

Alternatives — Courses of action which may meet the objectives of a proposal at varying levels of accomplishment, including the most likely future conditions without the project or action.

Altitheirmal — (Climatology) A period of time when it was much warmer than now, approximately 7,000–4,500 years before the present time. Also see *Anathermal* and *Medithermal*.

Altitude — The vertical distance of a level, a point, or an object considered as a point, measured from *Mean Sea Level (MSL)*.

Altitude Valve — A valve that automatically shuts off the flow into an elevated tank when the water level in the tank reaches a predetermined level. The valve automatically opens when the pressure in the distribution system drops below the pressure in the tank.

Alto cumulus Cloud — A fleecy cloud, usually a rounded mass, but which can change radically and unexpectedly, producing intermediate forms, at an average height of 2.5 miles (4 kilometers). A white or gray mid cloud which occurs as a layer or patch, primarily composed of water, the elements of which appear as rounded masses, rolls or globules. Also see *Cloud*.

Altostratus Cloud — A somewhat high level, blue to grayish blue cloud that forms a sheet or layer at an average height of 3.5 miles (5.6 kilometers). It appears as a sheet or layer of striated, fibrous or uniform appearance. Also see *Cloud*.

Altum Mare — (Old English Law) The high seas; the deep sea.

Alum — Common name for commercial-grade *Aluminum Sulfate*. Its chemical formula is generally denoted by $\text{Al}_2(\text{SO}_4)_3 \cdot 12\text{H}_2\text{O}$ (number of bound water molecules will vary from 12 to 18).

Aluminum Sulfate — A white crystalline compound, $\text{Al}_2(\text{SO}_4)_3$, used chiefly in paper making, water purification, sanitation, and tanning. See *Alum*.

Ambient Air Quality Criteria — A scientific relationship between particular concentrations and durations of specific air contaminants and the effects they produce on persons, animals, plants, or materials.

Ambient Monitoring [EPA] — All forms of monitoring conducted beyond the immediate influence of a discharge pipe or injection well and may include sampling of sediments and living resources.

Ambient Water Quality Standards — The allowable amount of materials, as a concentration of pollutants, in water. The standard is set to protect against anticipated adverse effects on human health or welfare, wildlife, or the environment, with a margin of safety in the case of human health. Also see *Primary* and *Secondary Standards* and *7Q10*.

Amebic Dysentery — A disorder of the gastrointestinal tract caused by a protozoan parasite belonging to the genus *Entamoeba histolytica*. The disorder is commonly found in communities with poor sanitary conditions, particularly related to water and food storage and preparation. Infected individuals experience abdominal cramps, diarrhea, and blood and mucus in the feces. The parasite invades the liver in some cases.

Amendment — A change to an existing water right permit, water right, or vested right such as adding diversion points, moving diversion points or irrigated acreage, changing water uses, etc. An amendment may not increase the rate of diversion or increase the volume of water or impair existing water rights.

American Association of State Climatologists — The American Association of State Climatologists is a professional scientific organization composed of state climatologists (one per state), directors of the six Regional Climate Centers, and associate members who are persons interested in the goals and activities of the Association. State Climatologists are individuals who have been identified by a state entity as the state's climatologist and who are also recognized by the Director of the National Climatic

Data Center of the *National Oceanic and Atmospheric Administration (NOAA)* as the state climatologist of a particular state. State Climatologists currently exist in 47 states and Puerto Rico. They are typically either employees of state agencies or are staff members of state-supported universities. Associate members may be assistant state climatologists or other climatologists under the employ of the state climatologist; representatives of federal climate agencies; retired state climatologists; or others interested in climate services. The total membership of the Association is approximately 150.

American Heritage Rivers [Executive Order 13061] — The American Heritage Rivers initiative represented an innovative response to help river communities that sought federal assistance and other resources to meet difficult and frequently competing challenges with respect to their river systems. Without any new regulations on private property owners, state, local, and tribal governments, the American Heritage Rivers initiative was intended to make more efficient and effective use of existing federal resources, reduce inhibiting bureaucracy, and provide cross-agency assistance as necessary. The American Heritage Rivers initiative was borne out of Executive Order 13061, “Federal Support of Community Efforts Along American Heritage Rivers,” signed by President William J. Clinton on September 11, 1997. Section 1, Policies, established three primary objectives: (1) natural resource and environmental protection; (2) economic revitalization; and (3) historic and cultural preservation. The intent of the order was, “to the extent permitted by law and consistent with their missions and resources, federal agencies shall coordinate their plans, functions, programs, and resources to preserve, protect, and restore rivers and their associated resources important to our history, culture, and natural heritage.” While broad and sweeping in its intent, it was specifically noted that “agencies shall act with due regard for the protection of private property provided for by the Fifth Amendment to the United States Constitution (i.e., *Taking*). Also, no new regulatory authority was created as a result of the American Heritage Rivers initiative. The initiative would not interfere with matters of state, local, and tribal government jurisdiction.” Under the order, the President would designate rivers that meet certain criteria as “American Heritage Rivers.” Communities, in coordination with their state, local, or tribal governments, would nominate a river, river reaches, or river confluence for designation as an American Heritage River. A nominating committee (the American Heritage Rivers Interagency Committee) was designated to be composed of the following Executive Agency members or their designees at the Assistant Secretary level or equivalent:

- [1] Secretary of Defense;
- [2] Attorney General;
- [3] Secretary of the Interior;
- [4] Secretary of Agriculture;
- [5] Secretary of Commerce;
- [6] Secretary of Housing and Urban Development;
- [7] Secretary of Transportation;
- [8] Secretary of Energy;
- [9] Administrator of the Environmental Protection Agency;
- [10] Chair of the Advisory Council on Historic Preservation;
- [11] Chairperson of the National Endowment for the Arts; and
- [12] Chairperson of the National Endowment for the Humanities.

The Chair of the Council on Environmental Quality (CEQ) became a permanent co-chair. The committee’s other co-chair was to rotate among the heads of the member agencies. Once a river had been nominated to and designated by the President, the consistent with Title I of the National Environmental Policy Act of 1969, the above federal agencies shall:

- Identify their existing programs and plans that give them the authority to offer assistance to communities involved in river conservation and community health and revitalization;
- As permitted by law and regulation, refocus programs, grants, and technical assistance to provide support for communities adjacent to American Heritage Rivers;
- Identify all technical tools, including those developed for purposes other than river conservation, that can be applied to river protection, restoration, and community revitalization;
- Provide access to existing scientific data and information to the extent permitted by law and consistent with the agencies mission and resources;
- Cooperate with State, local, and tribal governments and communities with respect to their activities that take place in, or affect the area around, an American Heritage River;
- Commit to a policy in which they seek to ensure that their actions have a positive effect on the natural, historic, economic, and cultural resources of American Heritage River communities;
- Provide a single federal government representative (a “River Navigator”) with whom communities can communicate goals and needs to facilitate community-agency interchange;
- Allow public access to the river, for agencies with facilities along American Heritage Rivers, to the extent practicable and consistent with their mission; and
- Cooperate, as appropriate, with communities on projects that protect or preserve stretches of the river that are on federal property or adjacent to a federal facility.

The following represent American Heritage River’s Designated Rivers:

- [1] ***Blackstone and Woonasquatucket Rivers (Massachusetts, Rhode Island)*** – The Blackstone and Woonasquatucket Rivers played a key role in the industrial development of America. The 18 and one-half mile long Woonasquatucket River has a watershed area of 32,474 acres in six Rhode Island communities. The Blackstone River extends 46 miles from its headwaters in Worcester, Massachusetts to the head of Narragansett Bay in Providence, Rhode Island. Its watershed encompasses 24 communities and more than 350,000 acres, and includes the second and third largest

- cities in New England. The Blackstone Valley has been designated a National Heritage Corridor.
- [2] **Connecticut River (Connecticut, Vermont, New Hampshire, Massachusetts)** – The entire 410-mile length of the Connecticut, New England's mightiest river, has the honor of being an American Heritage River. It stands at the heart of this region's human settlement and commerce; at the core of its history and culture; and represents the essence of its environmental quality and economic vitality. Beginning at the U.S.-Canadian border, it forms the state line for Vermont and New Hampshire and traverses the midsections of Massachusetts and Connecticut, ending at Long Island Sound.
 - [3] **Cuyahoga River (Ohio)** – The entire 100-mile-long stretch of the V-shaped Cuyahoga River has been designated under the American Heritage River Initiative. This "Crooked River" has a watershed that drains 813 square miles of Geauga, Portage, Summit, and Cuyahoga Counties, which is less than three percent of the land area in Ohio, but supports nearly fifteen percent of its population. The Cuyahoga was made famous when it caught fire in June 1969 and dramatized to the nation the plight of America's rivers.
 - [4] **Detroit River (Michigan)** – The Detroit River, designated an American Heritage River in 1998, is part of the connecting channels linking Lake Huron to Lake Erie. It is an international border with our neighboring country of Canada. It serves as a source of drinking water for approximately five million people, is a key link for commerce in the Great Lakes-St. Lawrence Seaway system, and provides countless benefits for recreation. Entering the next millennium, the Greater Detroit area is poised for significant and sustainable renewal after decades of disinvestment and population loss; sustainability is now a large part of the context of this rebirth as noted by the fact that Detroit recently hosted the National Town Meeting for a Sustainable America (May 1999).
 - [5] **Hanalei River (Hawaii)** – The Hanalei River was recently selected as one of 14 American Heritage Rivers. Eleven federal agencies are slated to enter into a Memorandum of Understanding with the Hanalei River Hui (represented by the University of Hawaii) pledging their commitment to support community-based planning and projects. The Hanalei River is approximately 16 miles long from its source to the ocean. It is among the five largest rivers in Hawaii. It is a free-flowing river terminating in an estuarine bay, the third largest and most pristine in Hawaii. Together with its estuarine bay it is outstanding in Hawaii and in the Pacific for the abundance and quality of natural, cultural, and scenic resources.
 - [6] **Hudson River (New York)** – The Hudson River is one of America's most important commercial and recreational waterways and is recognized as an estuary of national importance. From its source at Lake of the Clouds to the Verrazano Narrows in New York Harbor, the Hudson River is an economic success story of new business and industry, productive agriculture, and waterfront communities springing back to life. Over 315 miles long, the Hudson River travels through 19 counties where more than 8 million people live, work, and play.
 - [7] **Lower Mississippi River (Louisiana, Tennessee)** – The American Heritage Rivers designated stretch of the Lower Mississippi River on the south end runs from the Gulf of Mexico to the limits of deep water navigation, including the city of New Orleans and parishes of Ascension, East Baton Rouge, Iberville, Jefferson, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist and West Baton Rouge in Louisiana. On the north end, the designated area runs where the river traverses the Memphis metro area, including the Nonconnah Creek and Wolf River tributaries, encompassing all of Shelby County, Tennessee and the rich flood plain in Arkansas.
 - [8] **New River (North Carolina, Virginia, West Virginia)** – New River Community Partners (NRCP) is a new watershed-based nonprofit organization that is coordinating American Heritage River activities in the 21 counties in three states that make up the New River watershed.
 - [9] **Rio Grande River (Texas)** – This is the nation's second longest river and is rich in natural resources and vestiges of a frontier past. It also provides a two-thousand-mile border between Texas and the Mexican States of Tamaulipas, Nuevo Leon, Coahuila and Chihuahua, and a gateway for North American Free Trade Agreement commerce.
 - [10] **Potomac River (District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia)** – The Potomac American Heritage River covers the entire 14,670 square mile Potomac watershed, including major tributaries such as the South Branch, North Branch, Shenandoah, Monocacy, Anacostia, and Occoquan Rivers. This watershed extends through four states (Virginia, West Virginia, Maryland, Pennsylvania) and the District of Columbia. The basin is predominately forested (approximately 55 percent), with smaller areas of agriculture and urban and suburban development. Some five million people live in the basin, with more than three and one-half million of them in the Washington, D.C., metropolitan area. Almost all of this metropolitan area is in the Potomac watershed.
 - [11] **St. Johns River (Florida)** – The St. Johns River, 310 miles in length, is the longest river in Florida. Among its many distinct characteristics, the St. Johns is one of few major rivers in the nation that flow north. The St. Johns River and its tributaries drain about one-sixth of the state of Florida, or about 8,700 square miles. The river flows from its headwaters in marshes southwest of Cape Canaveral, evolving into a series of lakes, finally maturing into a river averaging two miles in width for its final one hundred miles into Jacksonville, and the Atlantic Ocean.
 - [12] **Upper Mississippi River (Iowa, Illinois, Minnesota, Missouri)** – Fifty-seven communities and over 250 supporting organizations worked together to achieve designation of the Upper Mississippi River as an American Heritage River. The stretch of the river within which the communities are located begins in the headwaters area of Bemidji, Minnesota, flows through five states, and ends in St. Louis, Missouri. Three small communities asked to join the initiative after designation and now a total of 58 communities are participating.
 - [13] **Upper Susquehanna and Lackawanna Rivers (Pennsylvania)** – The Upper Susquehanna-Lackawanna Watershed, as delineated by the U.S. Geological Survey, comprises nearly 1,800 square miles of land and almost 1,600 miles of perennial rivers and streams. Lackawanna and Luzerne counties constitute the core of the watershed, which

includes portions of several other counties and more than 150 municipalities. The corridor begins along the Lackawanna at Thompson, proceeds to the confluence of the Lackawanna with the Susquehanna at Pittston, and follows the Susquehanna through the Wyoming Valley to Sunbury. The watershed includes the Wyoming and Lackawanna Valleys, plus adjoining mountainous areas that provide headwaters for the numerous streams that flow to the Susquehanna. Its major urban centers are Wilkes-Barre and Scranton. Other population centers within the watershed include Bloomsburg, Carbondale, Dickson City, Dunmore, Hazleton, Kingston, Nanticoke, and Pittston. In 1990, approximately 640,000 people lived in the region.

- [14] **Willamette River (Oregon)** – The Willamette River Basin is located in northwestern Oregon between the Cascade Mountains and the Coast Range. The basin comprises 11,500 square miles and is bordered by foothills and mountains up to 10,000 feet high to the south, east, and west. The Willamette flows north to the Columbia River, joining it just ten feet above sea level.

American Public Works Association (APWA) — A national organization founded in 1894 and based in Chicago, Illinois of individuals and organizations involved in the management of municipal solid waste and in the design and operation of wastewater treatment plants.

American Rivers — A nonprofit conservation organization dedicated to protecting and restoring rivers throughout the United States. American Rivers was founded in 1973 and is North America's leading river conservation organization. Its mission is to protect and restore America's river systems and to foster a river stewardship ethic. American Rivers has identified a number of primary threats to rivers of the United States:

- [1] **Dams** – Reduce river levels; alter river flow patterns; block fish passage; slow current; change water temperature; decrease oxygen levels important for healthy fish and vegetation; hold back silt, debris, and nutrients; cut up fish in generator turbines; and increase predator risk.
- [2] **Channelization** – Cuts off rivers from floodplains; eliminates nutrients from rivers; robs rivers of the ability to build new sand bars, islands, and side channels; and increases river depth and velocity, forcing fish to use more energy.
- [3] **Urban Sprawl** – Pollutes runoff; destroys habitat; creates impermeable surfaces (which decreases groundwater infiltration, increases flooding, and adds to waterway pollution).
- [4] **Agriculture** – Creates farm chemical pollution and animal waste pollution; and supports livestock grazing which damages streamside habitat and erosion.
- [5] **Resource Extraction** – Increased pollution, sedimentation, and erosion from logging and mining operations.
- [6] **Water Diversions** – Reduced instream flows from irrigation diversions and municipal and industrial use, and hydropower generation (which also raises water temperatures).

Principal goals of American Rivers include:

- [1] **Reform the U.S. Army Corps of Engineers** – Reform the Corps and restore thousands of miles of rivers to their natural flow.
- [2] **Community Riverfronts** – Put the river back in city riverfronts thereby creating a plan that's good for both the river ecosystem and community interests.
- [3] **Dam Removal** – Remove dams that don't make sense, thereby restoring rivers, bring back fish and wildlife, improve recreation opportunities, and revitalize communities.
- [4] **Hydropower Dam Reform** – License renewal affords an opportunity to change the way hydropower dams operate, securing more natural instream river flows and improving conditions for fish, wildlife, boaters, other riparian uses.
- [5] **Fish and Wildlife** – Freshwater animals are the most threatened group of species in the U.S., and protecting freshwater fish and wildlife means protecting our rivers.
- [6] **Floodplains and Wetlands** – Restoration of floodplain and wetland habitats, encouraging non-structural alternatives to flood control, and helping people understand the risks of floodplain development and wetland eradication leads to improvement of the overall health of a river and preserves critical habitat for fish and wildlife.
- [7] **Land Use and Urban Sprawl** – Logging, mining, grazing, and urban development have all taken a toll on watersheds and rivers and need to be more closely monitored.
- [8] **Water Quality** – Runoff from streets, parking lots, farms, and residential yards, as well as pollution from industrial sites all threaten rivers, fish, and wildlife, and our communities from poor water quality.
- [9] **Water Quantity and Instream Flows** – Instream flows influence nearly every major watershed in the U.S., thereby also affect all wildlife and human uses derived from these watersheds.
- [10] **Wild and Scenic Rivers** – Securing Wild and Scenic River designations and defending the concept of the Wild and Scenic Rivers Act is necessary to preserve the heritage of wild rivers for generations to come.

Below is a listing and summary of threats for American River's most endangered rivers of 2001.

- [1] **Missouri River (Montana, North Dakota, South Dakota, Nebraska, Iowa Kansas, Missouri)** – Several species of Missouri River wildlife face extinction because the operation of six federal dams prevents the natural rise and fall of water levels to facilitate limited barge traffic downstream from Sioux City, Iowa.
- [2] **Canning River (Arctic National Wildlife Refuge, Alaska)** – Concerns exist over the extension of Alaska's Prudhoe Bay oil fields, across the Canning River, and into the Arctic National Wildlife Refuge.
- [3] **Eel River (California)** – Once among California's most productive salmon rivers, the Eel River has been reduced to virtually a trickle due to hydropower generation and interbasin water transfers to the Russian River for agricultural and municipal use.

- [4] **Hudson River (New York)** – The river system suffers from the release of more than a million pounds of toxic PCBs over a 30-year period as the result the manufacture of electric transformers.
- [5] **Powder River (Wyoming and Montana)** – The booming Coal Bed Methane (CBM) industry in the Powder River basin has created a threat of shallow discharging large quantities of poor quality water before the methane can be extracted.
- [6] **Mississippi River (Minnesota, Wisconsin, Iowa, Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, Louisiana)** – Two large flood control projects proposed by the U.S. Army Corps of Engineers along the Mississippi and its tributaries would destroy more than 200,000 acres of rare floodplain wetlands.
- [7] **Big Sandy River (West Virginia and Kentucky)** – In October 2000 a failed slurry impoundment in Kentucky cracked sending 250 million tons of water, mud, and coal waste surging into the Tug Fork of the Big Sandy River, killing all river life in more than 75 miles of stream.
- [8] **Snoqualmie River (Washington)** – Sprawling development threatens the future of the Snoqualmie River, which produces some of the largest salmon runs in the state of Washington.
- [9] **Animas River (Colorado and New Mexico)** – The Animas-La Plata (ALP) water project – one of the last big Western water projects – threatens endangered fish species, a thriving recreational rafting industry, riverbank wetlands, and a gold medal trout fishery on the Animas River in southwestern Colorado.
- [10] **East Fork Lewis (Washington)** – A proposed 4,000-ton-a-day gravel mine expansion along the East Fork of the Lewis River in Washington state threatens crucial spawning and rearing habitat for three species of salmon that are listed as “threatened” under the *Endangered Species Act (ESA)*.
- [11] **Paine Run (Virginia)** – Paine Run, in Virginia's Shenandoah National Park, and other mountain streams and rivers throughout the Mid-Atlantic are slowly being killed by acid rain blowing in from old coal-fired power plants in the Ohio and Tennessee valleys, making them too acidic to sustain wild brook trout populations.
- [12] **Hackensack River (New York and New Jersey)** – The Hackensack River and the Meadowlands wetlands in New York and New Jersey face rapidly escalating development pressure that threatens to destroy a significant portion of the largest block of wetlands left in the region and increase the amount of pollution entering reservoirs that supply drinking water for one million people.
- [13] **Catawba River (North and South Carolina)** – Explosive urban growth along the Catawba River in North and South Carolina threatens to overwhelm the river's capacity to provide drinking water, assimilate sewage, support wildlife, and serve the recreational needs of Charlotte and growing communities throughout the basin.

American Society of Civil Engineers (ASCE) — A professional organization in New York City founded in 1852 that supports the practice of, and research in, environmental engineering, hydrology, and water and wastewater treatment.

American Water Resources Association (AWRA) — The vision of the American Water Resources Association is to be recognized as the pre-eminent multidisciplinary association for information exchange, professional development, and education about water resources and related issues. The AWRA's mission is to advance multidisciplinary water resources management and research. The AWRA currently has over 2,800 members, and in addition, over 700 subscribers to the *Journal of the American Water Resources Association*. The Association's conferences, symposia, and publications are widely regarded for their technical content and contributions to the water resources community.

American Water Works Association (AWWA) — The American Water Works Association is an international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply. Founded in 1881, AWWA is the largest organization of water supply professionals in the world. Its more than 50,000 members represent the full spectrum of the drinking water community: treatment plant operators and managers, scientists, environmentalists, manufacturers, academicians, regulators, and others who hold genuine interest in water supply and public health. Membership includes more than 4,000 utilities that supply water to roughly 180 million people in North America. The AWWA mission and vision is dedicated to the promotion of public health and welfare in the provision of drinking water of unquestionable quality and sufficient quantity. AWWA must be proactive and effective in advancing the technology, science, management, and government policies relative to the stewardship of water.

Amictic Lake — (1) A lake that does not experience mixing or turnover on a seasonal basis. (2) A perpetually frozen lake that does not undergo mixing of the water column. Also see *Dimictic Lake*.

Ammonia — A chemical used with *Chlorine* to disinfect water.

Ammonia Stripping — A process for the removal of *Ammonia* from wastewater. The waste is first made alkaline to favor the NH_3 form, and then aerated so that exchange between the water and the atmosphere is encouraged. Stripping towers are often used, with the waste trickling downward as air is forced upward through the tower.

Ammonification — The transformation of organic nitrogen to ammonia, generally by means of bacterial activity.

Ammonium Sulfate — A brownish-grey to white crystalline salt, $(\text{NH}_4)_2\text{SO}_4$, used in fertilizers and water purification.

Amoeba, also Ameba — A protozoan of the genus *Amoeba* or related genera, occurring in water and soil and as a parasite in other animals. An amoeba has no definite form and consists essentially of a mass of protoplasm containing one nucleus or more surrounded by a delicate, flexible outer membrane. It moves by means of pseudopods.

Amoeboid Glacier — A *Glacier* that is connected with its snowfield for only a part of the year.

Amorphous Frost — A frost that lacks crystalline structure.

Amortization — For tax purposes, writing off against income a portion of the cost of capital assets in each of several years. Rapid amortization is a write-off in a fewer number of years than the capital equipment might be in use, such as five-year amortization for pollution-control equipment that might have a life longer than a five-year period as for water works projects.

Amphibian — (1) A cold-blooded, smooth-skinned vertebrate of the class *Amphibia*, such as a frog or salamander, that

- characteristically hatches as an aquatic larva with gills. The larva then transforms into an adult having air-breathing lungs. (2) An animal capable of living both on land and in water.
- Amphibiotic** — Living in water during an early stage of development and on land during the adult stage.
- Amphibious** — (Biology) (1) Living or able to live both on land and in water. (2) Able to operate both on land and in water.
- Ampoules** — A sealed, liquid-filled tube which is broken to release or be filled with another fluid.
- Amplitude** — (1) The extent of vibratory movement of oscillation. (2) The elevation of the crest of a wave above the adjacent troughs.
- Ampermeteric Titration** — A means to measure concentrations of certain substances in water using an electric current that flows during a chemical reaction. Also see *Titration*.
- Anabaena** — Any of various freshwater algae of the genus *anabaena* that sometimes occur in drinking water and cause a bad taste and odor.
- Anabranh** — (1) A stream that diverges from the main stream or river and later rejoins the main flow downstream. (2) A stream that diverges from the main stream or river and later rejoins the main flow downstream. (3) A branch of a stream that gets lost in sandy soil. Also referred to as a *Valley Braid*.
- Anadromous** — (1) Fish species which live in salt water but migrate periodically into fresh water streams for spawning. (2) Pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn, for example, salmon, steelhead trout, and shad. Contrast with *Catadromous*.
- Anadromous Fishery Restoration Program (AFRP) [California]** — See *Central Valley Project Improvement Act (CVPIA) [California]*.
- Anaerobe** — An organism that does not require oxygen to maintain its life processes.
- Anaerobic** — (1) Characterizing organisms able to live and grow only where there is no air or free oxygen, and conditions that exist only in the absence of air or free oxygen. (2) A condition in which molecular oxygen is virtually absent from the soil.
- Anaerobic Decomposition** — The degradation of materials by *Anaerobic* microorganisms living beneath the ground or in oxygen-depleted water to form reduced compounds such as methane or hydrogen sulfide. Generally a slower process than *Aerobic Decomposition*.
- Anaerobic Digester** — An airtight tank in which *Anaerobic* microorganisms decompose organic material and produce *Biogas*, mainly *Methane*. Sewage treatment plants often use anaerobic digesters to reduce the volume of *Sludge* produced in *Primary* and *Secondary Treatment*, and they sometimes use the methane as a heating fuel.
- Anaerobic Digestion** — (Wastewater Treatment) (1) The degradation of organic matter by microorganisms in the absence of oxygen, particularly as related to the treatment of sewage sludge. Sewage treatment plants often use anaerobic digesters to reduce the volume of sludge produced in primary and secondary treatment, and they sometimes use the resultant methane gas as a heating fuel. (2) In this process, wastewater solids and water (about 5 percent solids, 95 percent water) are placed in a large tank where bacteria decompose the solids in the absence of dissolved oxygen. At least two general groups of bacteria act in balance: (1) *Saprophytic* bacteria break down complex solids to volatile acids, the most common of which are acetic and propionic acids; and (2) *Methane Fermenters* break down the acids to methane, carbon dioxide, and water.
- Anaerobic Sediment** — (Geology) A highly organic sediment formed in hydrogen sulfide-rich water where limited circulation results in the absence or near absence of oxygen at the surface of the sediment.
- Anaerobiosis** — Microbiological activity under *Anaerobic* conditions.
- Anaho Island National Wildlife Refuge (NWR) [Nevada]** — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Anaho Island NWR was established in 1913 by President Woodrow Wilson to protect the white pelican nesting colonies. The Anaho NWR consists of the 750-acre (1.2 square mile) Anaho Island located within Pyramid Lake, which is wholly contained within the Pyramid Lake Paiute Indian Reservation. Situated approximately 45 northeast of Reno, Nevada, the Anaho NWR contains one of the largest white pelican nesting colonies in North America, as well as cormorant, great blue heron, and gull nesting colonies. This refuge is closed to the public for the protection of the colony nesting birds. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.
- Analog** — A continuously variable electrical signal representing a measured quantity. For example, electrical signals such as current, voltage, frequency, or phase used to represent physical quantities such as water level, flow, and gate position.
- Analytical Model** — A model that provides approximate or exact solutions to simplified forms of the differential equations for water movement and solute transport. Such models generally require the use of complex calculations and the use of computers.
- Anastatic Water** — Underground water within the *Capillary Fringe*. Also referred to as *Fringe Water*.
- Anastomosing** — The branching and rejoining of channels to form a netlike pattern.
- Anastomosing Stream** — See *Braided Stream*.
- Antithermal** — (Climatology) The period preceding the *Altithermal*; the early *Holocene* epoch from about 10,000–7,000 years before the present. Also see *Medithermal*.
- Anchialine** — (Ecology) Describing coastal seawater habitats that do not have a surface connection to the sea.
- Anchor** — A series of methods used to secure a structure to its footings or foundation wall so that it will not be displaced by flood or wind forces.
- Anchor Ice** — (1) Frazil ice that has collected on rocks on the stream bed. (2) Underwater ice that is formed on submerged objects or that is attached to the bottom of a body of water that itself is not frozen.
- Anchor Ice Dam** — An accumulation of anchor ice which acts as a dam and raises the water level.
- Ancient Water Course** — A water course is said to be “ancient” if the channel through which it naturally runs has existed from time immemorial independent of the amount of water which it discharges.
- Aneroid** — Not using liquid.

Angiosperms (Angiospermea) — (Botanical) The vast majority of seed plants characterized as having ovules and seeds in a closed ovary. Along with the *Gymnosperms (Gymnospermae)*, Angiosperms comprise a structurally superior class within the plant family *Spermatophyta*, or seed plants. Its two sub-classes consist of *Monocotyledones* and *Dicotyledones*. Also see *Gymnosperms*.

Angle of Current — In gaging streams, the difference between 90E and the angle made by the current with a measuring section.

Angler-Day — The time spent fishing by one person for any part of a day.

Anhydride — A chemical compound formed from another, often an acid, by the removal of water.

Anhydrite — A mineral, CaSO_4 , anhydrous calcium sulfate, common in evaporate beds.

Anhydrous — Without water, especially water of crystallization; not hydrated (*Dehydrated*).

Anion — (1) A negative ion. (2) In an electrolyzed solution, the negatively charged particle, or ion, which travels to the anode and is therefore discharged, evolved, or deposited. Also, by extension, any negative ion.

Anion Exchange — Ion exchange process in which anions in solution are exchanged for other anions from an ion exchanger.

Anisotropic — Having some physical property that varies with direction.

Anisotropy — (1) The condition of having different properties in different directions. (2) The condition under which one or more of the hydraulic properties of an aquifer vary according to the direction of the flow.

Annual Flood — The highest peak discharge of a stream in a *Water Year*.

Annual Flood Series — A list of annual floods for a given period of time.

Annual Low-Flow — The lowest flow occurring each year, usually the lowest average flow for periods of perhaps 3, 7, 15, 30, 60, 120, or 180 consecutive days.

Annual Overdraft — The quantity by which the production of water from the groundwater supplies during the water year exceeds the natural replenishment of such groundwater supplies during the same water year.

Annual Runoff — The total quantity of water in runoff for a drainage area for the year. Data reports may use any of the following units of measurement in presenting annual runoff data: (1) acre-feet (AC-FT, acre-ft, af) – the quantity of water required to cover 1 acre to a depth of 1 foot and is equal to 43,560 cubic feet, 325,851 gallons, or 1,234 cubic meters; (2) cubic feet per second per square mile (CFSM, $(\text{ft}^3/\text{s})\text{mi}^2$) – the average number of cubic feet of water flowing per second from each square mile of area drained, assuming the runoff is distributed uniformly in time and area; (3) inch (In., in.) – the depth to which a drainage area would be covered with water if all the runoff for a given time period was uniformly distributed on it.

Annual 7-Day Minimum [USGS] — The lowest mean discharge for 7 consecutive days in a year. Note that most low-flow frequency analyses of annual 7-day minimum flows use a climatic year (i.e., April 1-March 31). The date shown in *U.S. Geological Survey (USGS)* statistical tables is the initial date of the 7-day period. This value should not be confused with the 7-day 10-year low-flow statistic.

Annual Storage — The capacity of a reservoir that can contain the annual runoff of a watershed, but cannot carry over any water for longer than the year.

Annular Space — The space between two cylindrical objects, one of which surrounds the other, such as the space between the wall of the drilled hole and the casing, or between a permanent casing and the borehole.

Annulus — (1) The space between the drill string or casing and the wall of the borehole or outer casing. (2) For a well, the space between the pipe and the outer wall (casing) of the borehole, which may be a pipe also (the well casing).

Annulus Pressure — The positive pressure maintained by a fluid introduced between the well piping and the outer wall (casing) of the borehole of an underground *Injection Well* providing an indication of the integrity of the well.

Anomalistic Tide Cycle — (Oceanography) The average period of about 27.55 days during which the moon makes one complete revolution around the Earth.

Anoxia — (1) Absence of oxygen. (2) The total deprivation of oxygen, as in bodies of water, lake sediments, or sewage. (3) Literally means “without oxygen.” A condition in which a body or parcel of water loses all dissolved oxygen. Fish and other animals must either swim to a different area or die from lack of oxygen. Also see *Hypoxia*.

Anoxia, Functional — Although not well defined, generally refers to a body of water sufficiently deprived of oxygen to where *Zooplankton* and fish would not survive.

Anoxic — (1) Denotes the absence of oxygen, as in a body of water. (2) Of, relating to, or affected with anoxia; greatly deficient in oxygen; oxygenless as with water.

Antecedent Moisture — The degree of wetness of soil at the beginning of a runoff, determined by summation of weighted daily rainfall amounts for a period preceding the runoff.

Antecedent Moisture Condition (AMC) — (1) A description of the amount of water in storage at some point in time (usually the start of a hydrologic event) that is relevant to the event. (2) Soil moisture at the onset of a rainfall event. The U.S. Department of Agriculture, *Natural Resources Conservation Service (NRCS)*, formerly the *Soil Conservation Service (SCS)*, defines AMC in terms of total rainfall during the 5 days immediately preceding the rainfall event. Dry AMC conditions mean less than 1.4 inches, average is 1.4 to 2.1 inches, and wet is greater than 2.1 inches.

Antecedent Precipitation — Precipitation which occurred prior to a particular time over a specific area or *Drainage Basin*. Usually applied as a measure of moisture in the top layer of the soil which would affect runoff from additional rainfall. Also see *Antecedent Precipitation Index (API)*.

Antecedent Precipitation Index (API) — An index of moisture stored in a basin before a storm, calculated as a weighted summation of past daily precipitation amounts. Also see *Antecedent Precipitation*.

Antecedent Precipitation Index (API) Method [NWS] — (Climatology) A statistical method to estimate the amount of surface runoff which will occur from a basin from a given rainstorm based on the antecedent precipitation index, physical characteristics of the basin, time of year, storm duration, rainfall amount, and rainfall intensity.

Antecedent Soil Water — Degree of wetness of a soil prior to irrigation or at the beginning of a runoff period, typically expressed as an index.

Antecedent Stream — A stream that existed before the present topography and that has maintained its original course after and despite local geologic changes, such as uplift. As the mountains rise, the streams cut through at the same rate and so maintain their positions.

Anteconsequent Stream — A stream whose course, in its earlier stages, was determined by the general form and slope of the recently formed land surface on which the stream originated, and that maintained this course despite later geologic changes.

Antediluvian (Policy) — (1) Extremely old and antiquated. (2) Occurring or belonging to the era before the Flood written about in the Bible. (Ecology) Used sometimes today to denote a public growth and water policy based on an area's *natural* ability to support population growth only through existing, readily available natural resources, i.e., water.

Anthropogenic — Involving the impact of man on nature; induced, caused, or altered by the presence and activities of man, as in water and air pollution.

Anticyclone — An area of relatively high pressure in which, in the northern hemisphere, the winds tend to blow spirally outward in a clockwise direction.

Antidegradation Policy (or Clause) — Rules or guidelines that are required of each state by federal regulations implementing the *Clean Water Act (CWA)*, stating that existing water quality be maintained even if the current water quality in an area is higher than the minimum permitted as defined by federal ambient water quality standards. Some controlled degradation is permitted in support of economic development.

Antidegradation Statement — A statement, normally issued by a public body or regulatory agency, that protects existing designated uses and prevents high-quality waterbodies from deteriorating below the water quality necessary to maintain existing or anticipated designated beneficial uses.

Antifreeze — A substance, often a liquid such as ethylene glycol or alcohol, mixed with another liquid, such as water, to lower its freezing point.

Antifluoridationist — One who is strongly opposed to the fluoridation of public water supplies.

Antipollution Devices — Any mechanical equipment used to reduce hazard to the environment in cases of malfunction or shutdown of chemigation equipment during *Chemigation* and may include, but is not limited to, interlock, waterline check valve, chemical line closure device, vacuum relief device and automatic low pressure drain.

Anti-Seepage Collar — A projecting collar, usually of concrete, built around the outside of a pipe, tunnel, or conduit, or conduit under or through an *Embankment Dam* to lengthen the seepage path along the outer surface of the conduit.

Anthropogenic — Man-made; arising from human activities.

Apex — (1) The highest point on an *Alluvial Fan* or similar landform below which the flow path of the major stream that formed the fan becomes unpredictable and *Alluvial Fan Flooding* can occur. (2) The point of highest elevation on an alluvial fan, which on undisturbed fans is generally the point where the major stream that formed the fan emerges from the mountain front.

Aphotic — Defined as without light. Of or relating to the region of a body of water that is not reached by sunlight and in which *Photosynthesis* is unable to occur. The *Aphotic Zone* of the ocean is the water deeper than about 800 meters (2,625 feet), beyond which no light penetrates. Contrast with *Photic Zone*. Also see *Aphytic Zone*.

Aphotic Zone — (Oceanography) The deeper parts of the ocean, where there is insufficient light for plants to carry on photosynthesis.

Aphytic Zone — (Ecology) A lake floor that has no plant growth because it is too deep to be reached by light. Also referred to as the *Aphytal Zone* and *Aphotic Zone*.

Apothecaries' Measure — A system of liquid volume measure used in pharmacy.

Apparent Water Table — See *Perched Water Table*.

Applicable or Appropriate Requirements (ARARs) — Any state or federal statute that pertains to the protection of human life and the environment in addressing specific conditions or use of a particular cleanup technology at a *Superfund Site*.

Application Rate — For irrigation, the rate at which water is applied per unit of land area, usually expressed in terms of inches per hour.

Application, Water Right — An official request for permission to develop a source of water or to change an existing water right; includes a description of the proposed project, a map of the project, and a legal description of the property involved. The application for a water right will typically consist of the following information:

- [1] the total amount of water to be diverted or pumped;
- [2] the rate of flow (diversion);
- [3] the point of diversion or pumpage;
- [4] the point or place of use;
- [5] the manner of (beneficial) use; and
- [6] the period of use (continuous pumpage, seasonal diversion, etc.).

The application process is the first step in a process of obtaining a certificate of use or a *Perfected Water Right*. This process includes:

- [1] the filing of the application, which establishes the priority date for appropriation purposes;
- [2] the permit which is issued by the *State Engineer* or other approving authority;
- [3] the proof of completion which is filed by the applicant;
- [4] the proof of beneficial use which is also filed by the applicant; and
- [5] the certificate or perfected water right which is issued by the State Engineer or other approving authority.

Applied Water Demand — The quantity of water delivered to the intake of a city's water system or factory, the farm headgate or other point of measurement, or a marsh or other wetland, either directly or by incidental drainage. For instream use, it is the portion of the stream flow dedicated to instream use or reserved under federal or state legislation such as *Wild and Scenic River Acts*. Applied water includes the water that returns to groundwater, a stream, canal, or other supply source that can be reused or recycled and thus is not the same as *Net Water Demand*.

Appropriate — To authorize the use of a quantity of water to an individual requesting it.

Appropriated Water — (1) A quantity of water from a well, stream, river, reservoir, or other source reserved for a specific use and place of use under state water-right laws, statutes, or regulations. (2) Surface water in an irrigation district that has been assigned or allocated to owners of water rights.

Appropriate Technology — The application of current scientific knowledge and technology in such a way so as to conform with existing economic, infrastructure, social, and cultural conditions and practices. By extension, the concept implies the implementation of low-technology solutions incorporating simplicity of design, use, and maintenance.

Appropriation — (1) An authorization granted by the state water appropriation/water rights officials to make a private, beneficial use of the state's water resources. (2) A granting process whereby authority is granted by a state to divert, store, or use the public waters of the state. Often used interchangeably with the terms water right and water permit.

(Prior) Appropriation Doctrine — The system for allocating water to private individuals used in the western United States under which (1) the right to water was acquired by diverting water and applying it to a beneficial use and (2) a right to water acquired earlier in time is superior to a similar right acquired later in time. In most states water rights are not now acquired by diverting water and applying it to a beneficial use. Such a system is referred to as the constitutional method of appropriation. Water rights are acquired by application, permit, and license, which may not require diversion and application to a beneficial use. Superiority of right is based on earliest in time and has no reference to whether two rights are for a similar use. The doctrine of *Prior Appropriation* was in common use throughout the arid west as early settlers and miners began to develop the land. The prior appropriation doctrine is based on the concept of "*First in Time, First in Right*." The first person to take a quantity of water and put it to *Beneficial Use* has a higher priority of right than a subsequent user. Under drought conditions, higher priority users are satisfied before junior users receive water. Appropriative rights can be lost through nonuse; they can also be sold or transferred apart from the land. Contrast with *Riparian Water Rights*.

Appropriative Water Right — A right to a source and quantity of water based on physical control of the water as determined by a permitting process or license for its beneficial use. Unlike Riparian Rights, which require abutment or contiguity to a surface water source, appropriative rights exist without regard to the special relationship of land and water. It is based on physical control, beneficial use, and a special permit or license describing the source waters to be appropriated, the point of diversion, the quantity of water or its rate of flow, the period of diversion, and the specific beneficial use.

Appropriative Water Right [California] — Unlike most other states, California operates under *Dual Water Right* system of both *Riparian Water Rights* and *Appropriative Water Rights*. Except in certain cases, groundwaters are not regulated nor do they require permitting as do surface waters. Before 1913, appropriators' notices to divert water for beneficial use in California could be filed voluntarily with the county recorder in the area of the diversion. If a notice was not filed, the appropriative water right dated back to the time that the first substantial steps were taken to put the water to beneficial use. According to the rules of appropriation, the right to the full future volume of water would then "relate back" or have a priority date from the time that the first substantial actions were taken towards effecting the diversion, which may include the building of a dam or weir or the construction of a flume or ditch system. A permitting system was subsequently established in California in 1913 which required that new appropriations of surface waters be permitted from the state prior to the appropriation. The application must state the place of use, period of diversion, purpose for which the water will be used, and the point and type of diversion. The permit also requires that the water right holder will measure the quantity of water diverted or the quantity of water passing by the diversion.

Appropriative Water Right [Nevada] — Nevada's water law is based on statutes enacted in 1903 and 1905 and are founded on the principal of *Prior Appropriation*. Unlike some other states, Nevada has a statewide system for the administration of both groundwater and surface water. Appropriative water rights are based on the concept of applying water to *Beneficial Use* and "*First in Time, First in Right*." Appropriative water rights can be lost through nonuse and they may be sold or transferred apart from the land. Due in large part to the relative scarcity of water in Nevada and numerous competing uses, Nevada has had a thriving market for water transfers for a number of years. A person in Nevada who desires to place water to beneficial use must file an application with the State Engineer to initiate the process of acquiring an appropriative water right. Also see *Riparian Water Rights*, *Prescribed Water Rights*, and *Reserved Water Rights (Federal)*.

Appropriator — One taking water from a watercourse under the authority of the state and applying it to *Beneficial Use*.

Approximate Original Contour — The surface configuration achieved by backfilling and grading of mined areas so that the reclaimed area, including any terracing or access roads, closely resembles the general surface configuration of the land prior to strip mining and blends into and complements the drainage pattern of the surrounding terrain.

Appurtenant — (1) (Legal) A right, privilege, or property that is considered incident to the principal property for purposes such as passage of title, conveyance, or passage of title. (2) (Water-Related) A right to water that is incident to the ownership or possession of the land.

Appurtenant Land — The land base to which water rights legally pertain or belong.

Appurtenant Structures (of a Dam) — Auxiliary features of a dam such as an outlet, spillway, powerhouse, tunnel, etc.

Appurtenant to Place of Use — A water right has several characteristics, one of which is the location of where the water will be put to beneficial use. An *Appurtenant Water Right* is a water right that belongs to the legal owner of the land described as the place of use of the water right.

Appurtenant Water Right — A water right that is incident to the ownership or possession of land.

Apron — (1) Any device made to protect a surface of the earth from the damaging power of moving water, such as a platform that receives water falling over a dam. (2) A platform, as of planking, at the entrance to a dock. (3) A covering or structure along a shoreline for protection against erosion. A platform serving a similar purpose below a dam or in a sluiceway. (Geology) (4) An area covered by sand and gravel deposited in the front of a glacial moraine. (5) A continuous, broad, blanket-like accumulation of alluvial, glacial, or other unconsolidated material commonly formed at the base of a mountain or in front of a glacier.

Aqua — Water; an *Aqueous* solution. A prefix meaning water, e.g., *Aquaculture*.

Aquacade — (1) A water spectacle originated at Cleveland, Ohio, in 1937; (2) A water spectacle that consists usually of exhibitions of swimming and diving with musical accompaniment.

Aquaculture, also Aquiculture — The science, art, and business of cultivating marine or freshwater food fish or shellfish, such as oysters, clams, salmon, and trout, under controlled conditions for commercial purposes.

Aqualf — (Geology) A suborder of the soil order *Alfisol* that develops in water-saturated areas and is characterized by a gray or mottled color.

Aquanaut — A person trained to live in underwater installations and conduct, assist in, or be a subject of scientific research. Also called *Oceanaut*.

Aquarium — (1) A tank, bowl, or other water-filled enclosure in which living fish or other aquatic animals and plants are kept. (2) A place for the public exhibition of live aquatic animals and plants.

Aquarius — (1) A constellation in the equatorial region of the Southern Hemisphere near Pisces and Aquila also referred to as the *Water Bearer*. (2) The 11th sign of the zodiac in astrology.

Aquatic — (1) Consisting of, relating to, or being in water; living or growing in, on, or near the water. (2) Taking place in or on the water. (3) An organism that lives in, on, or near the water.

Aquatic Algae — Microscopic plants that grow in sunlit water containing phosphates, nitrates, and other nutrients. Algae, like all aquatic plants, add oxygen to the water and are important in the fish food chain.

Aquatic Assemblage — An association of interacting populations of organisms in a given waterbody, for example, fish assemblage, or a benthic macroinvertebrate assemblage.

Aquatic Biodiversity — An indication of the variety of life and the ecosystems that make up the freshwater, tidal, and marine regions of the world and their interactions. Aquatic biodiversity encompasses freshwater ecosystems, including lakes, ponds, reservoirs, rivers and streams, groundwater, and wetlands. The banks of streams or riparian areas are also important areas associated with freshwater systems. It also consists of marine ecosystems, including oceans, estuaries, salt marshes, tidal fringe wetlands, seagrass beds, coral reefs, kelp beds, and mangrove forests. Aquatic ecosystems also provide a home to many plant and animal species including phytoplankton, zooplankton, aquatic plants, insects, fish, birds, mammals, and others. They are organized at many levels, from the smallest building blocks of life to complete ecosystems, encompassing communities, populations, species, and genetic levels. In summary, aquatic biodiversity includes all unique species and habitats, and the interaction between them. Also see *Biodiversity*.

Aquatic Community — (Ecology) (1) An association of interacting populations of aquatic organisms in a given water body or habitat. (2) An association of interacting assemblages in a given waterbody, the biotic component of an *Ecosystem*.

Aquatic Community Classification System — A component part of *The Nature Conservancy's (TNC) Freshwater Initiative (FWI)*. According to this concept, in nature, species of plants and/or animals that are often found together are called communities. A community classification system exists for plants, but until recently no unified framework existed for classifying aquatic species into communities. The advantage of a framework for classifying communities is that the information it provides upon application in a particular geographic area helps conservation planners select places (or stream stretches, i.e., reaches) within that area that are most important for protecting the full complement of *Biodiversity*. Recognizing the importance of such a system, TNC staff developed an aquatic community classification framework based on biotic assemblages and on the abiotic characteristics of stream reaches and their contributing watersheds. This classification framework incorporates biological information and landscape-scale abiotic information (incorporated into *Geographic Information System* data layers) that describe aquatic ecosystem characteristics. By developing and now applying this framework across the Americas, TNC will be better able to direct its limited resources to conserve important freshwater biodiversity into the next millennium.

Aquatic Ecosystem — (Ecology) (1) Any water-based *Ecosystem*, such as a stream, a pond, lake, or an ocean. (2) The stream channel, lake or estuary bed, water, and (or) biotic communities and the habitat features that occur therein.

Aquatic Habitat — (Ecology) Environments characterized by the presence of standing or flowing water.

Aquatic Integrity — The overall condition of a waterbody including chemical, physical (habitat) and biological components. The integrity condition is generally based on a comparison to a reference which is a relatively undisturbed system and represents the best quality to be expected for the *Ecoregion*.

Aquatic Invasive Species — The term “invasive species” can refer to any plants, animals, or other viable biological material or organisms that enter an *Ecosystem* beyond its historic range. They are also called “alien species,” “invasive species,” “nonnative species,” “aquatic nuisance species,” “introduced species,” “exotic organisms,” “xenobiotic organisms,” and probably other terms as well. The majority of invasive species introduced into new ecosystems never become established due to unfavorable environmental factors. Of those that do become established, many go unnoticed and cause no significant environmental harm. However, an increasing number of invasive species are causing significant adverse impacts to the environment and potential risks to human health. Invasive species can successfully invade any terrestrial or aquatic ecosystem, and may enter through a wide variety of introduction mechanisms. Human activities, both intentional and non-intentional, are the chief cause of invasive species introductions. It has been estimated that ship *Ballast Water* alone carries some 10,000 non-indigenous aquatic organisms to foreign ports each day. Also see *Aquatic Nuisance Species (ANS)*.

Aquatic Life — All forms of living things found in water, ranging from bacteria to fish and rooted plants. Insect larva and zooplankton are also included.

Aquatic Life Use — A beneficial use designation in which the waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms.

Aquatic Nuisance Species (ANS) — Specifically, Aquatic Nuisance Species are *Aquatic Invasive Species*, ranging in size from microscopic to large plants and free-swimming fish, that displace native species, degrade native habitats, spread disease, and disrupt human social and economic activities that depend on water resources. Any ship carrying *Ballast Water* is a potential invasion source for ANS. In recent years there has been increased international concern for the threats to human health, aquaculture, and coastal environments from aquatic nuisance species and diseases. The United States Coast Guard has responded to these concerns through a comprehensive national *Ballast Water Management Program*. This program (a) promotes ballast water management for operators of all vessels in waters of the U.S.; (b) provides voluntary ballast water management guidelines for all vessels entering U.S. waters from outside of the Exclusive Economic Zone (EEZ); and (c) requires the reporting of ballast water management data by all vessels entering U.S. waters from outside of the EEZ.

Aqueduct — (1) A pipe, conduit, or channel designed to transport water from a remote source, usually by gravity. (2) A bridgelike structure supporting a conduit or canal passing over a river or low ground. (3) A structure for transporting water from one place to another by means of a pipeline, canal, conduit, tunnel or a combination of these conveyance means.

Aquent — (Geology) A suborder of the soil order *Entisol* that develops in areas periodically saturated with water and is characterized by a bluish-gray or greenish-gray color.

Aqueous — (1) Relating to, similar to, containing, or dissolved in water; watery. (2) (Geology) Formed from matter deposited by water, as certain sedimentary rocks.

Aqueous Lava — (Volcanology) Mud lava formed as a result of the mixture of volcanic ash with water or condensing volcanic vapor.

Aquept — (Geology) A suborder of the soil order *Inceptisol* that develops in areas where restricted natural drainage results in water saturation; characterized by a dark surface horizon over a mottled or gray subsoil.

Aqui — A prefix for water, e.g., *Aquifer*.

Aquic — A mostly reducing soil moisture regime nearly free of dissolved oxygen due to saturation by groundwater or its capillary fringe and occurring at periods when the soil temperature at 50 centimeters is above 5°Celsius (41°Fahrenheit).

Aquiclude (Confining Bed) — A formation which, although porous and capable of absorbing water slowly, will not transmit water fast enough to furnish an appreciable supply for a well or spring. Aquicludes are characterized by very low values of “leakage” (the ratio of vertical *Hydraulic Conductivity* to thickness), so that they transmit only minor inter-aquifer flow and also have very low rates of yield from compressible storage. Therefore, they constitute boundaries of aquifer flow systems.

Aquiculture — See *Aquaculture*. Compare with *Mariculture*.

Aquifer — (1) A geologic formation, a group of formations, or a part of a formation that is water bearing. Porous, water-saturated layers of sand, gravel, or bedrock that can yield an economically significant amount of water. (2) A geological formation or structure that stores or transmits water, or both, such as to wells and springs. (3) An underground layer of porous rock, sand, or gravel containing large amounts of water. Use of the term is usually restricted to those water-bearing structures capable of yielding water in sufficient quantity to constitute a usable supply. (4) A sand, gravel, or rock formation capable of storing or conveying water below the surface of the land. (5) Any geological formation containing water, especially one that supplies water for wells, springs, etc. The technical word for *Groundwater*. (6) A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs. (7) A permeable body of rock or other geologic structure that contains and conducts economically significant quantities of groundwater to supply wells and springs.

Aquifer, Basin-Fill — An aquifer located in a basin surrounded by mountains and composed of sediments and debris shed from those mountains. Sediments are typically sand and gravel with some clay.

Aquifer Compaction — Term used to describe the effects of emptying or overdrawing an aquifer; overdrafts tend to collapse the structure of the aquifer such that the original volume cannot be restored. May also be associated with a general *Land Subsidence* in the surrounding ground level as the result of such compaction.

Aquifer, Confined — An aquifer which is bounded above and below by formations of impermeable or relatively impermeable material. An aquifer in which groundwater is under pressure significantly greater than atmospheric and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the aquifer itself. See *Artesian Aquifer*.

Aquifer, Fractured Bedrock — An aquifer composed of solid rock, but where most water flows through cracks and fractures in the rock instead of through pore spaces. Flow through fractured rock is typically relatively fast.

Aquifer, Leaky (Semi-Confined) — An aquifer overlaid and/or underlain by a thin semipervious layer through which flow into or out of the aquifer can take place.

Aquifer, Perched — A groundwater unit, generally of moderate dimensions, that occurs whenever a groundwater body is separated from the main groundwater supply by a relatively impermeable stratum and by the *Zone of Aeration* above the main water body.

Aquifer, Saline/Poor Quality — An aquifer containing water that is high in total dissolved solids, and is unacceptable for use as drinking water.

Aquifer, Sandstone — The type of aquifer supplying groundwater to large parts of the United States upper Middle West, Appalachia, and Texas. The water-bearing formation is often contained by shale strata, and the water has high levels of iron and magnesium.

Aquifer Stimulation — A type of development that is done in semi-consolidated and completely consolidated formations to alter the formation physically to improve its hydraulic properties.

Aquifer System — A body of permeable and relatively impermeable materials that functions regionally as a water-yielding unit. It comprises two or more permeable units separated at least locally by confining units (*Aquitards*) that impede ground-water movement but do not greatly affect the regional hydraulic continuity of the system. The permeable materials can include both saturated and unsaturated sections.

Aquifer Test — (1) A test involving the withdrawal of measured quantities of water from or addition of water to a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition. (2) A test to determine hydrologic properties of an aquifer, involving the withdrawal of measured quantities of water from, or the addition of water to, a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition (recharge).

Aquifer, Unconfined — An *Aquifer* made up of loose material, such as sand or gravel, that has not undergone lithification (settling). In an unconfined aquifer the upper boundary is the top of the *Zone of Saturation* (i.e., the *Water Table*).

Aquifer, Volcanic Rock — An aquifer composed of rock that originated from a volcano, such as basalt. This type of rock may or may not be very permeable.

Aquifuge — A formation that has no interconnected openings and hence cannot absorb or transmit water.

Aquiherbosa — (Ecology) The herbaceous plant communities of ponds and swamps.

Aquiprata — (Ecology) The plant communities influenced by the presence of groundwater in damp meadows.

Aquitard — A saturated, but poorly permeable bed that impedes ground-water movement and does not yield water freely to wells, but which may transmit appreciable water to or from adjacent aquifers and, where sufficiently thick, may constitute an important ground-water storage unit. Aquitards are characterized by values of leakance that may range from relatively low to relatively high. Areally extensive aquitards of relatively low leakance may function regionally as boundaries of aquifer flow systems.

Aquod — (Geology) A suborder of the soil order *Spodosol* that develops in water-saturated areas as a result of fluctuating water tables or humid climates; characterized by a black surface horizon, a white albic horizon, or a cemented spodic horizon.

Aquoll — (Geology) A suborder of the soil order *Mollisol* that develops in areas periodically saturated with water; characterized by a black surface horizon over a mottled or gray subsoil.

Aquox — (Geology) A suborder of the soil order *Oxisol* that develops in areas periodically saturated with water and is characterized by a mottled subsoil.

Aquult — (Geology) A suborder of the soil order *Ultisol* that develops in areas periodically saturated with water and is characterized by a gray or mottled color.

Arable Land — Land capable of being cultivated and suitable for the production of crops. The (U.S. Department of the Interior) *Bureau of Reclamation (USBR)* defines arable land as: "Land which, in adequate units and when properly provided with the essential improvements of leveling, drainage, buildings, irrigation facilities and the like, will have a productive capacity, under sustained irrigation agriculture, sufficient to: meet all production expenses, including a reasonable return on investment; repay reasonable irrigation and improvement costs; and provide a satisfactory level of living for the farm family."

Arboretum — A collection of plants, trees, and shrubs grown for public exhibition, public enjoyment, recreation, education, or research.

Arboriculture — The planting, care, and tending of trees and shrubs, individually or in small groups, for utilitarian purposes.

Arch Dam — (1) Curved masonry or concrete dam, convex in shape upstream, that depends on arch action for its stability; the load or water pressure is transferred by the arch to the *Abutments*. (2) A dam construction type used in sites where the ratio of width to height between abutments is not great and where the foundation at the abutment is solid rock capable of resisting great forces. The arch provides resistance to movement. When combined with the weight of concrete (arch-gravity dam), both the weight and shape of the structure provide great resistance to the pressure of water. Also see *Dam*.

Arch-Gravity Structure — A structure which derives its resistance to the pressure of water from both an arching effect and its own weight.

Archimedean Screw — An ancient apparatus for raising water, consisting of either a spiral tube around an inclined axis or an inclined tube containing a tight-fitting, broad-threaded screw. Also referred to as *Archimedes' Screw*.

Arctic Tundra — The grassland *Biome* characterized by permafrost (subsurface soil that remains frozen throughout the year).

Arcuate Delta — (Geology) A curved delta whose convex outer margin faces the body of water. Also referred to as a *Fan-Shaped Delta*.

Are — A metric unit of land measure equal to 100 square meters or 1/100 *Hectare* (119.6 square yards). Also see *Metric System*.

Area Capacity Curve — A graph showing the relation between the surface area of the water in a reservoir and the corresponding volume at given elevations.

Area Flooded — Area of a floodplain that is flooded in a specific stream reach, watershed, or river basin; may be for a single flood event, but is usually expressed as an average, annual value based on the sum of areas from all individual flood events over a long period of time, such as 50 to 100 years, and adjusted to an average value.

Area (Sub-Area), Hydrographic — Primarily these are sub-drainage systems, typically valleys, within a more comprehensive drainage basin. *Hydrographic Areas* (Valleys) may be further subdivided into *Hydrographic Sub-Areas* based on unique hydrologic characteristics (e.g., differences in surface flows) within a given valley or area.

Area (Sub-Area), Hydrographic [Nevada] — Nevada's 14 major drainage *Basins* or *Hydrographic Regions* are divided further into 232 *Hydrographic Areas* (valleys) and 256 *Hydrographic Areas* and *Hydrographic Sub-Areas* as defined by the U.S. Geological Survey (USGS) and the Nevada Division of Water Resources, Department of Conservation and Natural Resources. See *Basins [Nevada]*.

Area of a Lake — The space occupied by the water surface. The area of a lake, generally, is something that cannot be determined with great exactitude; often the figure given is an arbitrary one, and figures from different sources show considerable

disagreements. This comes about, because some error is inherent in any of the procedures devised for determining area; because measurements may be made from hydrographic maps which differ in accuracy and detail, and in time at which the map was made.

This latter becomes important where lakes fluctuate greatly in levels. Some differences may arise also where different mathematical procedures are followed in making measurements. Also, often arbitrary decisions must be made as to location of shore line, the inclusion or exclusion of islands, and boundaries between a lake and connecting water, all of which consequently affect the computed area. Area is usually expressed square miles and acres; or where the metric system is used in square kilometers and square meters.

Area of Critical Environmental Concern (ACEC) — An area on *Public Lands* where special management attention is required to protect and prevent irreparable damage to historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, or to protect people from natural hazards.

Area of Critical Environmental Concern (ACEC) [Nevada] — Any area in the State of Nevada where there is or could develop irreversible degradation of more than local significance, but does not include an area of depleting water supply which is caused by the beneficial use or storage of water in other areas pursuant to legally owned and fully appropriated water rights. (Nevada Revised Statutes 321.655)

Area of Influence — (1) The area covered by the drawdown curves of a given pumping well or combination of wells at a particular time. (2) The area surrounding a pumping or recharging well within which the water table or potentiometric surface has been changed due to the well's pumping or recharge.

Area of Origins Protection — (1) Generally, laws, regulations, or policies that provide some form of protection to states, counties, or regions from which an interbasin transfer of water is made. (2) State and federal laws, dating back to 1931, enacted to guarantee that the counties that contribute water to state and federal water projects will get priority for water when it is needed to match future growth. As yet, these statutes have not received close legal scrutiny by the courts.

Area of Review — The area around an underground injection well that may be influenced adversely by fluid injection. Typically, the extent of this area may be calculated by using the specific gravity and rate of introduction of the injected fluids, the size, storage capacity, and hydraulic conductivity of the injection zone, and certain underground formation pressures.

Area of Shallow Flooding — Designated *Flood Zones* AO and AH on a community's *Flood Insurance Rate Map (FIRM)* with a one percent or greater annual chance of flooding to an average depth of one to three feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet flow. Also referred to as *Sheet Flow Area*.

Area of Special Flood Hazard — See *Special Flood Hazard Area*.

Area of Special Flood-Related Erosion Hazard — The land within a community which is most likely to be subject to experience flood-related erosion losses. The area may be designated as Zone E on the *Flood Insurance Rate Map (FIRM)*. See *Flood Zones*.

Area of Special Mudslide (i.e., Mudflow) Hazard — The area subject to severe mudslides (i.e., mudflows). The area is designated as Zone M on the *Flood Insurance Rate Map (FIRM)*.

Argenta Marsh [Nevada] — Formerly referred to as the Tule Swamps, the Lakes, Big Slough, and the Argenta Swamp, the Argenta Marsh was an extensive riparian and wetland area totaling an estimated 12,000 to 15,000 acres located throughout a considerable portion of the Humboldt River's floodplain between Argenta and Battle Mountain in north-central Nevada. Until it was drained and the Humboldt River channelized through the area in 1950's by the *U.S. Army Corps of Engineers* (Corps), acting in cooperation with the *U.S. Bureau of Reclamation* (BOR), this area represented one of the most productive and naturally-protected wildlife habitats along the entire Humboldt River system. Its open waters, direct connections to the Humboldt River's main and south channels, the region's labyrinth of sloughs, swamps and braided and abandoned river channels and oxbows, thick expanses of tules, and dense stands of tall willows formed an invaluable and virtually inaccessible wetland refuge for a wide variety of wildlife. The area's proliferation of wildlife, particularly water fowl, was only surpassed by the nearly impenetrable nature of its vegetation. Reportedly, Peter Skene Ogden and his Hudson's Bay Company fur trappers took some 1,500 beavers from the area in two trapping seasons in the early 1830's. Early emigrants through the region were forced to detour around this area due to the saturated ground and dense vegetation. Later, local hunters were frequently stymied in their efforts to reap some rewards from the abundant wildlife present due to the virtual inaccessibility of the willow stands. Despite these difficulties, the productivity of the region was legendary. Historical accounts of the Argenta Marsh from journals and newspapers of the late 1800's speak of "wagon loads of fish" and "hundreds of ducks" being taken by local sportsmen who braved this area's natural obstacles. The original wetland area below Argenta, as surveyed and mapped out under contract for the Surveyor General of Nevada in May 1869, included two distinct open water areas totaling some 2,740 acres, which were then known as the Tule Swamps (or the "Lakes"). One mapped open water area, located immediately below Argenta, was approximately one mile wide and nearly four miles long and contained some 2,060 acres through which the South Channel of the Humboldt River ran. It was generally referred to as the "Argenta Marsh". The main channel of the Humboldt River was located approximately one mile to the north of this upper marsh open water swamp area. The second swamp or lake area, consisting of some 680 acres, was about one-half to one mile wide and one and one-half miles long and was also bisected by the Humboldt River's South Channel. It was located about one mile northeast of the site of Battle Mountain and just above the confluence of the South Channel and the Humboldt River main stem, hence the name given to it was generally the "Confluence Marsh". The Humboldt River's main channel formed the northern boundary of this lower marsh swamp and open water area. These two primary open water swamp areas were linked by approximately three miles of sloughs, oxbows, and braided and abandoned river channels affording invaluable riparian habitat for a wide variety of animal species. In 1934, the BOR and the Pershing County Water Conservation District (PCWCD) signed an agreement for a reclamation project (the "Humboldt Project") to effect delivery of water to Rye Patch Reservoir, located in the lower Humboldt River Basin. Near Battle Mountain the BOR began buying water rights for transfer to Rye Patch Reservoir. Subsequently, Corps channelized a section of the river between Argenta and Battle Mountain

for the expressed purpose of draining the Argenta Marsh or Swamp and moving the Humboldt River's waters more efficiently to the lower basin for storage and use in Lovelock Valley. As a consequence of these efforts, this entire wetland area was effectively drained and the riparian habitat and the wildlife that depended upon it lost. Presently, these lands, totaling nearly 30,000 acres, are arranged in 42 separate fields and administered as a "Community Pasture" by the PCWCD.

Argillic Alteration (Argillization) — A form of *Hydrothermal* alteration in which certain minerals of rock are converted to clay minerals.

Arid — A term applied to a climate or region where precipitation is so deficient in quantity, or occurs so infrequently, that crop production is impractical or impossible without irrigation.

Arid Climate — Generally any extremely dry climate.

Aridic — A soil moisture regime that has no moisture available for plants for more than half the cumulative time that the soil temperature at 19.7 inches (50 centimeters) is above 5EC (41EF) and has no period as long as 90 consecutive days when there is moisture for plants while the soil temperature at 50 centimeters is continuously above 8EC (46.4EF).

Aridity — The quality or state of being arid, dry, or barren.

Arithmetic Growth — (Statistics) A rate of increase (or decrease) by a constant amount per time period, for example a population increase of X persons per year, year after year. Compare to *Exponential Growth* and *Sigmoid Growth*.

Arithmetic Mean — (Statistics) The sum of a set of observations divided by the number of observations. Also referred to as simply the *Mean*, or the *Sample Mean*. Compare to *Mode* and *Median*.

Arm — (1) An inlet of water (as from the sea). (2) (Lakes) A long and relatively narrow body of water extending inland from a main body. Usually the term arm is applied to a reach of water, greater in length and narrower than one called a bay, but often on maps no clear distinction exists between arm and bay, nor between arm and lobe.

Arm of the Sea — A portion of the sea projecting inland, in which the tide ebbs and flows. It is considered as extending inland into the interior of a country to the extent to which fresh river waters are propelled backwards by the inflow of the tide.

Armor — To protect fill slopes, such as the sides of a levee, by covering them with erosion-resistant materials such as rock or concrete.

Armored Mud Ball — (Geology) A large, roundish mass of clay or silt that collects a coating of coarse sand and fine gravel as it rolls downstream. Also referred to as a *Pudding Ball*.

Armored Riverbed — A riverbed from which easily removed sediment has been eroded, leaving a surface of cobbles or boulders.

Armoring — (1) Formation of a layer of rocks on the surface of a streambed that resists erosion by water flows. The rocks can be naturally occurring, caused by the scour of smaller particles from high discharges, or placed by humans to stop channel erosion. (2) A facing layer (protective cover), or *Rip Rap*, consisting of very large stones placed to prevent erosion or the sloughing off of a structure or embankment. Also, a layer of large stones, broken rocks or boulders, or precast blocks placed in random fashion on the upstream slope of an *Embankment Dam*, on a reservoir shore, or on the sides of a channel as a protection against waves, ice action, and flowing water. The term armoring generally refers only to very large rip rap.

(United States) Army Corps of Engineers (Corps or COE) — Originally formed in 1775 during the Revolutionary War by General George Washington as the engineering and construction arm of the Continental Army. Initially, the Corps of Engineers built fortifications and coastal batteries to strengthen the country's defenses and went on to found the Military Academy at West Point, help open the West, and to develop the nation's water resources. In its military role, the COE plans, designs, and supervises the construction of facilities to insure the combat readiness of the U.S. Army and Air Forces. In its civilian role, the COE has planned and executed national programs for navigation and commerce, flood control, water supply, hydroelectric power generation, recreation, conservation, and preservation of the environment. In a very general sense, the U.S. Army Corps of Engineers has a primary responsibility for water projects which protect property from potential flood damage, whereas the (U.S. Department of the Interior) *Bureau of Reclamation (USBR)* is responsible for primarily western water projects with respect to developing water sources for agriculture and commerce. In reality, however, quite often these federal agencies' project goals overlap with USBR's dams and reservoirs providing important flood protection and the COE's water projects — dams, locks, and canals — providing important water transportation linkages and benefits to commerce. The four levels in the Army Civil Works organization are the Assistant Secretary of the Army (Civil Works), the Corps national Headquarters in Washington, D.C., the 11 regional Corps Divisions and the 36 local Corps Districts. The regional Division and District offices are geographically aligned as follows:

- [1] **Lower Mississippi Valley Division:** Vicksburg, MS; Districts (4): Memphis, TX, New Orleans, LA, St. Louis, MO, Vicksburg, MS;
- [2] **Missouri River Division:** Omaha, NE; Districts (2): Kansas City, MO; Omaha, NE;
- [3] **New England Division:** Waltham, MA;
- [4] **North Atlantic Division:** New York, NY; Districts (4): Baltimore, MD, New York, NY, Norfolk, VA, Philadelphia, PA;
- [5] **North Central Division:** Chicago, IL; Divisions (5): Buffalo, NY, Chicago, IL, Detroit, MI, Rock Island, IL, St. Paul, MN;
- [6] **North Pacific Division:** Portland, OR; Districts (4): Anchorage, AK, Portland, OR, Seattle, WA, Walla Walla, WA;
- [7] **Ohio River Division:** Cincinnati, OH; Districts (4): Huntington, WV, Louisville, KY, Nashville, TN, Pittsburgh, PA;
- [8] **Pacific Ocean Division:** Fort Shafter, HI;
- [9] **South Atlantic Division:** Atlanta, GA; Districts (5): Charleston, SC, Jacksonville, FL, Mobile, AL, Savannah, GA, Wilmington, NC;
- [10] **South Pacific Division:** San Francisco, CA; Districts (3): Los Angeles, CA, Sacramento, CA, San Francisco, CA;

- [11] **Southwestern Division:** Dallas, TX; Districts (5): Albuquerque, NM, Fort Worth, TX, Galveston, TX, Little Rock, AR, Tulsa, OK.

Corps of Engineers Primary Mission and Objectives:

- [1] **Navigation Improvements** – to assist in the development, safety, and conduct of waterborne commerce;
- [2] **Flood Control** – to prevent or reduce flood damages and disruptions by accommodating flood flows in problem areas;
- [3] **Hurricane and Storm Damage Reduction** – preventing or reducing tidal and storm-related damage by building protective structures, such as dams or barriers, in estuaries; by raising the heights of dunes and natural beaches; and by building groins, dikes, seawalls or breakwaters;
- [4] **Coastal and Shoreline Erosion** – protect against ocean and lake shoreline erosion by providing seawalls, groins or other structures that reduce waves’ destructive effects; by filling and nourishing beaches and dunes to replace and maintain lost areas; and by planting vegetation that will hold and stabilize erodible materials; by preventing streambank erosion through the use of gabions, riprap and vegetative plantings;
- [5] **Water Supply** – at the request of local interests, include water supply storage in new projects, and modify existing projects for new or additional water supply storage, and in limited emergency circumstances, provide emergency supplies of clean water to a locality confronted by a source of contaminated water likely to cause a substantial threat to public health;
- [6] **Hydroelectric Power** – facilities for hydroelectric power are recognized as primarily the responsibility of non-federal interests; however, the Corps may include hydroelectric power development in multipurpose projects when it complements the major objectives of flood control or navigation;
- [7] **Outdoor Recreation** – facilitate the development of outdoor recreation facilities at Corps projects thereby providing a variety of opportunities for picnicking, camping, swimming, boating, hunting, fishing, hiking, and other pursuits;
- [8] **Environment** – per various federal requirements (*Fish and Wildlife Coordination Act*, *Endangered Species Act*, *National Historic Preservation Act*), a recognition that Corps projects must include not only facilities to mitigate unavoidable environmental damages, but also considerations of environmental restoration through opportunities created by the projects;
- [9] **Water Quality Control** – per *Federal Water Pollution Control Act (Clean Water Act)* requirements, the Corps is required to consider including water storage for regulation of stream flow and quality improvements in its reservoir and lake projects;
- [10] **Aquatic Plant Control** – per the *River and Harbor Act*, the Corps is authorized to conduct research and control or eradicate undesirable aquatic plants through research and application on the use of chemicals, mechanical harvesters, and natural enemies (insects, pathogens, and fish).

Arranged Delivery — Operation of a water delivery system to meet predetermined needs, generally based on user water orders. Also referred to as *Scheduled Delivery*.

Arrastra — A crude drag-stone mill for pulverizing ores, especially those containing free gold or silver; frequently powered by falling water.

Arroyo — (1) A water-carved channel or gully in an arid country which is usually rather small with steep banks and is dry much of the time due to infrequent rainfall and the shallowness of the cut, which does not penetrate below the level of permanent groundwater. (2) A deep, usually dry channel or gully carved by an *Ephemeral* or intermittent stream; common in the semiarid regions of the southwestern United States and Latin America. Derived from the Spanish word meaning “shaft” or “pit.”

Arroyo Valley — A small valley tributary to a major desert stream valley.

Artesian — (1) Refers to groundwater which is under sufficient pressure to rise above the *Aquifer* containing it. (2) An aquifer in which the water is under sufficient pressure to cause it to rise above the bottom of the overlying confining bed, if opportunity to do so should be provided. (3) A commonly used expression, generally synonymous with *Confined* and referring to subsurface (ground) bodies of water which, due to underground drainage from higher elevations and confining layers of soil material above and below the water body (referred to as an *Artesian Aquifer*), result in undergroundwater at pressures greater than atmospheric. (3) Relating to an *Artesian Well* or artesian aquifer.

Artesian Aquifer — (1) A *Confined Aquifer*. (2) A commonly used expression, generally synonymous with (but a generally less favored term than) confined aquifer. An artesian aquifer is an aquifer which is bounded above and below by formations of impermeable or relatively impermeable material. An aquifer in which groundwater is under pressure significantly greater than atmospheric and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the aquifer itself.

Artesian Basin — (1) An area of terrain that includes an *Artesian Aquifer*. (2) A body of groundwater more or less compact, moving through soils with more or less resistance.

Artesian Leakage — The slow percolation of water from an *Artesian Aquifer* into the beds that confine it.

Artesian Pressure — (1) The pressure under which *Artesian Water* in an *Artesian Aquifer* is subjected, generally significantly greater than atmospheric. (2) The natural force which causes water in a well penetrating an aquifer to rise above the top of the aquifer and produces flowing wells when the pressure is sufficient to force the water above the land surface.

Artesian Spring — A spring whose water flows from a fissure or other opening in the bed overlying an *Artesian Aquifer*.

Artesian Water — (1) Any confined *Groundwater* that is under sufficient pressure to rise above its confining bed. (2) The groundwater that is confined in an *Artesian Aquifer* under significantly greater pressure than that of the atmosphere, so that the water is capable of rising if given an opportunity to do so. (3) Groundwater that is under pressure when tapped by a well and is able to rise above the level at which it is first encountered. It may or may not flow out at ground level. The pressure in such

an aquifer commonly is called *Artesian Pressure*, and the formation containing artesian water is an artesian aquifer or *Confined Aquifer*.

Artesian Well — (1) A well that taps into water that is confined in an *Artesian Aquifer*. (2) Any well drilled into artesian waters as defined herein which flows naturally or is pumped by mechanical means. (3) A well bored down to the point, usually at great depth, at which the water pressure is so great that the water is forced out at the surface. The name is derived from the French region of Artois, where the oldest well in Europe was bored in 1126. (4) A well tapping a *Confined Aquifer* or artesian aquifer in which the static water level stands above the top of the aquifer. The term is sometimes used to include all wells tapping confined water. Wells with water levels above the unconfined water table are said to have positive artesian head (pressure) and those with water level below the unconfined water table, negative artesian head. If the water level in an artesian well stands above the land surface, the well is a *Flowing Artesian Well*. If the water level in the well stands above the water table, it indicates that the artesian water can and probably does discharge to the unconfined water body.

Artesian Zone — A zone where water is confined in an aquifer under pressure so that the water will rise in the well casing or drilled hole above the bottom of the confining layer overlying the aquifer.

Artificial Beach — A bathing beach created by removing peat or muck and subsequently filling with sand or fine gravel. Sand may also be spread over clay shore to create a more desirable beach. In a few instances sand is placed on a polyethylene (plastic) blanket which has been spread over soft bottom, but this kind of beach is not considered permanent. Groins are frequently constructed on the Great Lakes shoreline to trap shore drift thereby creating a beach.

Artificial Drainage — The use of human efforts and devices to remove free water from the soil surface or from the ground, or the use of human efforts and devices to prevent surface or ground water from reaching the soil. Dams and levees are included as devices that are used to artificially drain soils. The presence of artificial drainage does not alter the hydric status of a soil.

Artificial Lakes, Ponds — Basins purposely excavated by man and filled with water by catchment from run-off, by pumping or diversion of natural water bodies. Certainly artificial are those ponds constructed for farm use, for receiving factory wastes, sewage, etc. However, there are varying degrees of artificiality. Bodies of water impounded by dams across rivers are artificial only to a degree as are lakes whose basins have been altered by dredging or filling or whose levels has been raised or lowered respectively by dams across outlets or by dredging outlets. A gravel pit or stone quarry is patently an artificial basin, but its filling with water, after abandonment, may be a natural process. Ponds occupying mine cave-in pits cannot be classified as natural geomorphological features, nor are they intentionally constructed and filled with water by man. Wherever man has made use of the water or occupied the adjacent land, he has modified natural lakes to some degree, and to that degree made them artificial.

Artificial Recharge — (1) The addition of surface water to a groundwater reservoir by human activity, such as putting surface water into a *Spreading Basin*. (2) The addition of surface water to a groundwater reservoir by human activity, such as putting surface water into recharge basins. Also see *Groundwater Recharge* and *Recharge Basin*. (3) The designed (as per man's activities as opposed to the natural or incidental) replenishment of groundwater storage from surface water supplies such as irrigation or induced infiltration from streams or wells. There exist five common techniques to effect artificial recharge of a groundwater basin:

- [1] **Water Spreading** consisting of the basin method, stream-channel method, ditch method, and flooding method, all of which tend to divert surface water supplies to effect underground infiltration;
- [2] **Recharge Pits** designed to take advantage of permeable soil or rock formations;
- [3] **Recharge Wells** which work directly opposite of pumping wells, although they generally have limited scope and are better used for deep, confined aquifers;
- [4] **Induced Recharge** which results from pumping wells near surface supplies, thereby inducing higher discharge towards the well; and
- [5] **Wastewater Disposal** which includes the use of secondary treatment wastewater in combination with spreading techniques, recharge pits, and recharge wells to reintroduce the water into deep aquifers thereby both increasing the available groundwater supply and also further improving the quality of the wastewater.

Also referred to as *Induced Recharge*. Also see *Natural Recharge*, *Incidental Recharge*, *Injection*, and *Perennial Yield*.

Artificial Substrate — (1) A device placed in the water for a specified period of time that provides living spaces for a multiplicity of organisms; for example, glass slides, concrete blocks, multi-plate samplers, or rock baskets; used primarily to collect organisms in areas where the physical habitat is limiting or cannot be adequately sampled using conventional methods. (2) A device which is purposely placed in a stream or lake for colonization of organisms. The artificial substrate simplifies the community structure by standardizing the substrate from which each sample is taken. Examples of artificial substrates are basket samplers (made of wire cages filled with clean streamside rocks) and multiplate samplers (made of hardboard) for benthic organism collection, and plexiglass strips for periphyton collection.

Artificially Developed Water — Water which would not have reached a stream if left to flow in accordance with natural laws. If developed by an individual, that person may acquire rights to such waters superior to adjudicated rights of earlier appropriators of natural waters of the stream into which such waters are diverted.

As Nitrogen — An expression that tells how the concentration of a chemical is expressed mathematically. The chemical formula for the nitrate ion is NO_3 , with a mass of 62. The concentration of nitrate can be expressed either in terms of the nitrate ion or on terms of the principal element, nitrogen. The mass of the nitrogen atom is 14. The ratio of the nitrate ion mass to the nitrogen atom mass is 4.43. Thus, a concentration of 10 mg/L nitrate expressed as nitrogen would be equivalent to a concentration of 44.3 mg/L nitrate expressed as nitrate ion. When dealing with nitrate numbers it is very important to know how numeric values are expressed. A concentration of 22 mg/L nitrate expressed as nitrate ion sounds very high compared to a standard of 10mg/L, but the standard is expressed as nitrogen. Converting 22 mg/L nitrate expressed as nitrate is only 4.9 mg/L nitrate expressed as

nitrogen, less than half the drinking water standard. Older nitrate data (pre-1980) were commonly reported as nitrate, and that makes comparisons with the drinking water standard difficult. For purposes of drinking water regulations, standards are expressed in the form of the principal element.

Asbestos — A mineral fiber that can pollute air or water and cause cancer or *Asbestosis* when inhaled. The *U.S. Environmental Protection Agency (EPA)* has banned or severely restricted its use in manufacturing and construction.

Asbestosis — A disease associated with inhalation of *Asbestos* fibers. The disease makes breathing progressively more difficult and can be fatal.

Ash (Volcanic) — The finest rock material derived from volcanic explosions. Less than 4 mm in grain size.

Ash Mass — The mass or amount of residue present after the residue from the dry mass determination has been ashed in a muffle furnace at a temperature of 500 degrees Celsius for 1 hour. Ash mass of zooplankton and phytoplankton is expressed in grams per cubic meter, and periphyton and benthic organisms in grams per square meter.

Ash Meadows National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Ash Meadows NWR is located approximately 90 miles northwest of Las Vegas in Nye County, Nevada, and was established in 1984, encompasses some 14,000 acres (approximately 22 square miles) and provides critical habitat for 25 plant and animal species found nowhere else in the world. This distinguishes the Ash Meadows NWR as having the greatest concentration of endemic species of any other local area in the United States. Of the 25 unique species, 12 have been listed as either *Threatened* or *Endangered*. Water is the key natural resource which makes the Ash Meadows NWR a unique *Ecosystem* in the dry Mojave Desert. In this area, water-bearing strata come to the surface in approximately 30 seeps and springs, providing a rich and complex variety of habitat. The earliest efforts to protect this area were undertaken by *The Nature Conservancy*, which purchased 12,613 acres of land in 1984 and subsequently sold it to the USFWS specifically to establish a wildlife refuge. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Aspect — The compass direction toward which a sloping land area faces. The direction is measured downslope and normal to the contours of elevation.

Asperse — To sprinkle, especially with holy water.

Assemblage Structure — The make-up or composition of the taxonomic grouping such as fish, algae, or macroinvertebrates relating primarily to the kinds and number of organisms in the group.

Assessment Report — A comprehensive record of historical, existing and projected water quality conditions of a particular watershed.

Assignment of Water — The transfer of a water right application or permit from one person to another. This can be done in conjunction with the sale of land.

Assimilation — The ability of a body of water to purify itself of pollutants.

Assimilative Capacity — (1) The ability of a natural body of water to receive wastewaters or toxic materials without harmful effects and without damage to aquatic life. The ability of a lake to absorb nutrients or other potential pollutants without showing adverse effects. (2) The ability of air, a natural body of water, or soil to effectively degrade and/or disperse chemical substances. If the rate of introduction of pollutants into the environment exceeds its assimilative capacity for these substances, then adverse effects may result to habitat and wildlife.

(Lake) Association — Typically, a voluntary union of riparians whose purpose is management or development, or use or conservation of riparian lands and lake surface. Their union may vary from a gentlemen's agreement or may be in the form of a profit or non-profit corporation. In some instances the prospective buyer must become a member of the lake association prior to the purchase of frontage; continuous membership in the association becomes part of the purchase contract.

Association of Boards of Certification — An international organization representing boards which certify the operators of waterworks and wastewater facilities.

Asthenosphere — (1) The zone inside the earth beneath the *Lithosphere* constituting the source of *Igneous* rock (*Magma*). (2) The layer or shell of the Earth below the *Lithosphere* which is weak and in which isostatic adjustment takes place, magmas may be generated, and seismic waves are strongly attenuated.

Athalassohaline Lake — A term used to describe a saline lake which is not of marine origin. In this respect athalassohaline lakes differ from lakes formed by the isolation of part of the ocean in as much as those lakes originating from evaporation of fresh water is the importance of bivalent ions such as calcium, magnesium, and sulfate relative to the dominance of two monovalent ions (sodium and chloride) in sea water. The different ionic ratios are important biologically because the osmotic strength of a solution at a given level of *Total Dissolved Solids (TDS)* changes with the valence of the dominant ions. The individual ion concentrations are also important in that some ions are more toxic to fish than others.

Atmometer — An instrument used to measure the rate of evaporation.

Atmosphere — The gaseous layer covering the earth. The regions of the atmosphere are the *Troposphere*, *Stratosphere*, *Mesosphere*, *Chemosphere*, and the *Thermosphere* (which overlaps the *Ionosphere* and the *Exosphere*). The atmosphere is one of the four components, together with the *Lithosphere*, *Hydrosphere*, and *Biosphere*, that comprise the earth's ecosystem. Also see *Air*.

Atmospheric Deposition — The delivery of pollutants from the atmosphere to either land or water. Sometimes called *Air Deposition*, the deposition of an air pollutant on land or water can take several forms.

- [1] **Wet Deposition** — Precipitation (rain, sleet, snow) which brings pollutants into a system;
- [2] **Dry Deposition** — Pollutants deposited without precipitation: either as gasses or adsorbed to dust particles;
- [3] **Direct Deposition** — The deposition of pollutants directly onto the surface of a body of water; and
- [4] **Indirect Deposition** — Pollutants deposited on land which then wash into a body of water.

Atmospheric Evaporation — The passage of water in a gaseous state from the Earth's surface, including oceans, lakes, rivers, ice,

snow, and soil, into the *Atmosphere*.

Atrazine — A herbicide listed by the *U.S. Environmental Protection Agency (EPA)* as a “possible human carcinogen” and found frequently in streams and rivers, particularly following floods and periods of heavy rain and runoff from agricultural lands. Atrazine is used extensively for weed control for corn, sorghum, and sugarcane. Along with another common farm herbicide, *Cyanazine*, atrazine concentrations can soar to levels much higher than federal standards during the peak growing season. Atrazine is moderately volatile and soluble in water and resistant to natural degradation in water. Because of its chemical properties and widespread use as a herbicide, concerns have been raised over the potential risks posed by exposure of aquatic organisms to atrazine.

Attached Groundwater — (1) Groundwater that adheres to the walls of the spaces between subsurface particles of soil and rock. (2) The portion or amount of alkali substances in the ground sufficient to raise the pH value above 7.0 or to be harmful to the growth of crops, a condition called alkaline.

Attached Growth Processes — A wastewater treatment processes in which the microorganisms and bacteria treating the wastes are attached to the media in the reactor. The wastes being treated flow over the media. Trickling filters and rotating biological contactors are attached growth reactors. These reactors can be used for *Biochemical Oxygen Demand (BOD)* removal, *Nitrification* and *Denitrification*.

Attapulgite Clay — A colloidal, viscosity-building clay consisting of hydrous magnesium aluminum silicates and used principally in salt-water drilling fluids.

Attenuation — (1) Generally, a term used to describe the slowing, modification, or diversion of the flow of water as with *Detention* and *Retention*. (2) (Water Quality) The process of diminishing contaminant concentrations in groundwater, due to filtration, biodegradation, dilution, sorption, volatilization, and other processes. Also see *Natural Attenuation*.

Atterberg Limits — The transition points between various states of soil consistency. The Atterberg Limits consist of: (1) the liquid limit (water content at which the soil passes from the liquid to the plastic state); (2) the plastic limit (water content at which the soil passes from the plastic to the semi-solid state); and (3) the shrinkage limit (water content at which the soil passes from the semi-solid to the solid state).

(National) Audubon Society — A national environmental organization founded in 1905 and dedicated to the conservation and restoration of natural ecosystems with a focus on birds and other wildlife species for the benefit of humanity and the earth's biological diversity. Named after John James Audubon (1785-1851) who was one of the first American conservationists and who gained widespread recognition for his paintings of birds.

Augmentation Authority — A public agency authorized by a state legislature to secure an adequate water supply for a region or metropolitan area.

Aureole — (Astronomy) A faintly colored luminous ring appearing to surround a celestial body visible through a haze or thin cloud of water vapor, especially such a ring around the moon or sun, caused by the diffraction of light from suspended matter in the intervening medium. Also referred to as *Corona*.

Autecology — The branch of ecology dealing with the individual organism and its environment.

Autochthonous Material — (1) Pertaining to substances, materials, or organisms originating within a particular waterway and remaining in that waterway. (2) Organic material produced in the stream usually through primary production. Compare to *Allochthonous Material*.

Autochthonous Stream — A stream that is flowing in the channel in which it originated.

Autoconsequent Stream — A stream whose course is guided by the slopes of *Alluvium* it has itself deposited.

Autoconsequent Waterfall — One of a series of waterfalls that develop at particular sites along a stream course where part of the solution load is precipitated as a result of warming, evaporation, or other factors.

Autogenic Drainage — A drainage system that has developed only under the conditions of the surface over which the constituent streams flow.

Autoregression, or Autoregressive Process — (Statistics) A condition which exists whenever a lagged (i.e., prior period) value of the *Dependent Variable*, or the variable to be explained, appears as a regressor, that is, as an *Explanatory Variable*. The fundamental assumption is that future data values may be expressed as linear combinations of past observations. It is not uncommon in economics and other areas of scientific study for a variable to be influenced by its own behavior in prior periods. The problem with this equation (model) format is to insure that the lagged variable, represented below as Y_{t-1} , is independent of the disturbance term, ϵ_t . An example of a (first-order) autoregressive process, commonly termed AR(1), would be represented by:

$$Y_t = \phi_1 Y_{t-1} + \delta + \epsilon_t$$

where the parameter $\phi_1 < 1$, and δ is the (constant, time insensitive) trend component, and ϵ_t is the residual or disturbance term associated with each observation of Y_t .

Autotrophic Index — See *Biomass Pigment Ratio*.

Autotrophic Lake — (Ecology) A lake in which all or most of the organic material is derived from within the lake, rather than by drainage from the surrounding land.

Auxiliary Spillway — A dam spillway built to carry runoff in excess of that carried by the principal spillway; a secondary spillway designed to operate only during exceptionally large floods. Also referred to as *Emergency Spillway*. Also see *Spillway*.

Available Expansion — (Water Treatment) The vertical distance from the sand surface to the underside of a trough in a sand filter. This distance is also called *Freeboard*.

Available Nutrients — Nutrient ions or compounds in forms that plants can absorb and utilize in growth.

Available Water — (1) Soil or *Vadose Water* that is available for use by plants. (2) The portion of water in a soil that can be absorbed by plant roots, usually considered to be that water held in the soil against a tension of up to approximately 15 atmospheres. Also referred to as *Available Moisture*.

Available Water Content (AWC) — A measure of the relative amount of water available in the upper levels of the soil strata which is available for use by plants.

Available Water Holding Capacity — The capacity of a soil to hold water in a form available to plants. Also, the amount of moisture held in the soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Avalanche — (1) A large mass of snow or ice and accompanying materials moving rapidly down a steep slope. (2) A large mass of snow or ice, often mixed with rock or soil, sliding or falling rapidly down a slope under the force of gravity. (3) A fall or slide of a large mass, as of snow or rock, down a mountainside.

Avalanche Chute — The central track or path along which an avalanche has moved.

Avalanche Cone — The mass of material deposited where an avalanche has fallen, consisting of snow, ice, rock, soil, and all other material carried along by the force of the fall.

Average Annual Flood Damages — The weighted average of all flood damages that would be expected to occur yearly under specified economic conditions and development. Such damages are computed on the basis of the expectancy in any one year of the amounts of damage that would result from floods throughout the full range of potential magnitude.

Average Annual Recharge — The amount of water entering an aquifer on an average annual basis. In many, if not most, hydrologic conditions, “average” has little significance for planning purposes as there may exist so few “average” years in fact.

Average Annual Runoff (Yield) — The average of water-year (October 1-September 30) runoff or the supply of water produced by a given stream or water development project for a total period of record; measured in cubic feet per second or acre-feet.

Average Conditions — The conditions under which a numerical value for a hydrologic variable, such as precipitation or streamflow, is equal to the arithmetic mean for a selected time period. Also see *Natural Conditions*.

Average Discharge — In the annual series of the *U.S. Geological Survey's (USGS)* reports on surface-water supply, the arithmetic average of all complete water years of record whether or not they are consecutive. Average discharge is not published for less than 5 years of record. The term “average” is generally reserved for average of record and “mean” is used for averages of shorter periods, namely daily mean discharge.

Average Water Year — A term denoting the average annual *Hydrologic* conditions based upon an extended or existing period of record. Because precipitation, runoff, and other hydrologic variables vary from year to year, planners typically project future scenarios based on hydrologic conditions that generally include average, wet (high-water), and drought (low-water) years.

Average Year Water Demand — The demand for water under average *Hydrologic* conditions for a defined level of development.

Average Year Water Supply — The average annual supply of a water development system over a long period. For a dedicated natural flow, it is the long-term average natural flow for wild and scenic rivers or it is *Environmental Flows* as required for an average year under specific agreements, water rights, court decisions, and congressional directives.

Avoirdupois Weight — The system in common use in English-speaking countries for weighing all commodities except precious stones, precious metals, and drugs. In it 16 drams (dr.) make 1 ounce (oz.), 16 ounces make 1 pound (lb.). The pound contains 7,000 grains (453.59 grams) and is equal to 1.2153 pounds troy (or, 1 lb.=14.5833 troy oz.). There are two avoirdupois tons, the *long ton* (2,240 pounds) and the *short ton* (2,000 pounds), of which the long ton is the customary one in Great Britain and the short ton is used in the United States. Also see *Metric System*.

Avulsion — (1) The sudden movement of soil from one property to another as a result of a flood or a shift in the course of a boundary stream. (2) A forcible separation or detachment; a sudden cutting off of land by flood, currents, or change in course of a body of water; especially one separating land from one person's property and joining it to another's. (3) A sudden cutting off or separation of land by a flood or by an abrupt change in the course of a stream, as by a stream breaking through a meander or by a sudden change in current, whereby the stream deserts its old path for a new one. (4) A sudden loss or gain of land as the result of action of water or a shift in a bed of a river which has been used as a boundary by property owners. If land is lost as a result of avulsion the riparian owner does not lose title to the land that has been lost; the boundary lines remain the same. This is not true when land is lost by erosion.

Awash — Washed by the sea as level with or washed by waves. In such a position or way as to be covered with or as if with water.

AWWA — American Water Works Association.

Axial Flow — Fluid flow in the same direction as the axis of symmetry of the duct, vessel, or tank.

Axial Stream — (1) In a mountain valley, the main stream that flows through the deepest part and parallel to the longest dimension of the valley. (2) A stream whose course follows the axis of an anticline (a geologic fold sloping downward) or a syncline (a low trough-like area in bedrock). (3) A stream whose course follows the axis of an anticline or a syncline.

Axis (of a Dam) — The horizontal centerline of a dam in the longitudinal direction.

Azotobacter — Any of various rod-shaped, nonpathogenic, nitrogen-fixing bacteria of the genus *Azotobacter*, found in soil and water.

B

B-Horizon — (1) The lower soil zone which is enriched by the deposition or precipitation of material from the overlying zone, or *A-Horizon*. (2) A mineral horizon of a soil, below the A-horizon, sometimes called the *Zone of Accumulation* and characterized by one or more of the following conditions: an illuvial accumulation of humus or silicate clay, iron, or aluminum; a residual accumulation of sesquioxides or silicate clays; darker, stronger, or redder coloring due to the presence of sesquioxides; a blockly or prismatic structure. Constitutes part of the *Zone of Eluviation*.

Babble — To make a continuous low, murmuring sound, as flowing water.

BAC — See *Biological Activated Carbon (BAC) Process*.

Back Lands — Generally refers to lands lying back from and not contiguous to a highway or water course.

Back Marsh — (Ecology) Marshland formed in poorly drained areas of an alluvial plain.

Back Pressure — (1) A pressure that can cause water to *Backflow* into the water supply when a user's waste water system is at a higher pressure than the public system. (2) A pressure difference that can cause a non-potable material to backflow into the potable water supply when a physical connection exists with that material and the potable water supply.

Back Siphonage — (1) A form of backflow caused by a negative or below atmospheric pressure within a water system. (2) A reverse flow condition created by a difference in water pressures that causes water to flow back into the distribution pipes of a drinking water supply from any source other than the intended one. Also see *Backflow* and *Cross-Connection*.

Back Swamp — Marshy area of a flood plain at some distance from and lower than the banks of a river confined by natural levees.

Backbar Channel — A channel formed behind a bar connected to the main channel but usually at a higher bed elevation than the main channel. Backbar channels may or may not contain flowing or standing water.

Backfill, or Backfilling — process of filling the notches carved in the earth from strip mining in order to restore the original slope. This is intended to reduce soil erosion and allow for the reestablishment of vegetation.

Backflooding — The reversal of water flow at the water table as a result of changes in precipitation.

Backflow — (1) The backing up of water through a conduit or channel in the direction opposite to normal flow. (2) The undesirable flow of water from a plumbing system back into the community potable water supply (3) A reverse flow condition created by a difference in water pressures that causes water to flow back into the distribution pipes of a drinking water supply from any source other than the intended one. Backflow prevention assemblies prevent contamination and are required by city and state laws. Also see *Backsiphonage* and *Cross-Connection*.

Background Level — In toxic substances monitoring, the average presence of a substance in the environment, originally referring to naturally occurring phenomena.

Backflow Preventer — A device that allows liquids to flow in only one direction in a pipe. Backflow preventers are used on sewer pipes to prevent a reverse flow during flooding situations. Also referred to as a *Check Valve*.

Backroller — A broad *Reversal* of river flow such as that formed below a dam or ledge.

Backrush — The seaward return of water after the landward motion of a wave. Also referred to as *Backwash*.

Backset — An eddy or countercurrent in water.

Backshore — The part of a shore between the *Foreshore* and the landward edge that is above high water except in the most severe storms.

Backslope — The slope component that is the steepest, straight then concave, or merely concave middle portion of an erosional slope.

Backwash — (1) A backward flow of water, also referred to as *Backrush*. (2) (Water Quality) The process in which filter beds are subjected to water flow opposite to the service flow direction to loosen the bed and flush solid materials accumulated on the resin bed to waste. The reversal of flow through a rapid sand filter to wash clogging material out of the filtering medium and reduce conditions causing loss of head (pressure). (3) (Well Development) The surging effect or reversal of water flow in a well. Backwashing removes fine-grained material from the formation surrounding the borehole and thus can enhance well yield.

Backwashing — (1) The process of reversing the flow of water back through the filter media to remove the entrapped solids. (2) In a wastewater or water treatment facility, the flow of clean water in a direction opposite (upward) to the normal flow of raw water through rapid sand filters in order to clean them.

Backwater — (1) A small, generally shallow body of water attached to the main channel, with little or no current of its own. (2) A body of water that is backed up or turned back from its regular course by an obstruction, an opposing current, or a tide movement. (3) Any tranquil body of water lying parallel to a river or joined to a main stream and fed by *Backflow*. (4) A creek or series of lagoons parallel to the coast and separated from the sea, but fed through barred outlets. (5) Water backed up or retarded in its course as compared with its normal or natural condition of flow. In *Stream Gaging*, a rise in *Stage* produced by a temporary obstruction such as ice or weeds, or by the flooding of the stream below. The difference between the observed stage and that indicated by the *Stage-Discharge Relation*, is reported as backwater.

Backwater Curve — The longitudinal profile of the water surface in an open channel where the water surface is raised above its normal level by a natural or artificial obstruction. The term is sometimes used in a generic sense to denote all water surface

profiles, or profiles where the water is flowing at depths greater than critical.

Backwater Effect — The rise in surface elevation of flowing water upstream from and as a result of an obstruction to flow such as a narrow bridge opening, buildings or fill material that limits the area through which the water must flow. In stream gaging, a rise in stage produced by a temporary obstruction such as ice or weeds, or by the flooding of the stream below. The difference between the observed stage and that indicated by the stage-discharge relation is reported as backwater. Also referred to as heading up.

Backwater Flooding — Flooding caused by a restriction or blocking of flow downstream. Examples include a narrowing of the channel, logjam, ice jam, high flow in a downstream confluence stream, or high tide blocking high river flows from entering estuaries.

Backwater Gate — A gate installed at the end of a drain or outlet pipe to prevent the backward flow of water or wastewater. Generally used on storm sewer outlets into streams to prevent backward flow during times of flood or high tide. Also called a *Tide Gate*.

Backwater Pools — A pool type formed by an eddy along channel margins downstream from obstructions such as bars, rootwads, or boulders, or resulting from backflooding upstream from an obstructive blockage. Backwater pools are sometimes separated from the channel by sand or gravel bars.

Bacteria (Singular: Bacterium) — (1) Small one-celled animals, too small to be seen by the naked eye. Bacteria are found anywhere, including on and in the human body. Humans would be unable to live without the bacteria that inhabit the intestines and assist in digesting food. Only a small percentage of bacteria cause disease in normal, healthy humans. Other bacteria can cause infections if they get into a cut or wound. Bacteria are the principal concern in evaluating the microbiological quality of drinking water, because some of the bacteria-caused diseases that can be transmitted by drinking water are potentially life-threatening. (2) Microscopic one-celled organisms which live everywhere and perform a variety of functions. While decomposing organic matter in water, bacteria can greatly reduce the amount of oxygen in the water. They also can make water unsafe to drink. (3) Microscopic living organisms usually consisting of a single cell. Bacteria can aid in pollution control by consuming or breaking down organic matter in sewage, or by similarly acting on oil spills or other water pollutants. Some bacteria in soil, water or air may also cause human, animal and plant health problems. (4) Microscopic unicellular organisms, typically spherical, rod-like, or spiral and threadlike in shape, often clumped into colonies. Some bacteria cause disease, while others perform an essential role in nature in the recycling of materials, for example, decomposing organic matter into a form available for reuse by plants. Some forms of bacteria are used to stabilize organic wastes in wastewater treatment plants, oil spills, or other pollutants. Disease-causing forms of bacteria are termed “pathogenic.” Some forms of bacteria harmful to man include:

- [1] **Total Coliform Bacteria** — A particular group of bacteria that are used as indicators of possible sewage pollution. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°C. In the laboratory these bacteria are defined as all the organisms that produce colonies with a golden-green metallic sheen within 24 hours when incubated at 35°C plus or minus 1.0°C on M-Endo medium (nutrient medium for bacterial growth). Their concentrations are expressed as numbers of colonies per 100 milliliter (ml) of sample.
- [2] **Fecal Coliform Bacteria** — Bacteria that are present in the intestine or feces of warm-blooded animals. They are often used as indicators of the sanitary quality of the water. In the laboratory they are defined as all the organisms that produce blue colonies within 24 hours when incubated at 44.5°C plus or minus 0.2°C on M-FC medium (nutrient medium for bacterial growth). Their concentrations are expressed as numbers of colonies per 100 ml of sample.
- [3] **Fecal Streptococcal Bacteria** — Bacteria found also in the intestine of warm-blooded animals. Their presence in water is considered to verify fecal pollution. They are characterized as gram-positive, cocci bacteria which are capable of growth in brain-heart infusion broth. In the laboratory they are defined as all the organisms that produce colonies which produce red or pink colonies within 24 hours at 35°C plus or minus 1.0°C on KF-streptococcus medium (nutrient medium for bacterial growth). Their concentrations are expressed as numbers of colonies per 100 ml of sample.

Bacterial Culture — (Wastewater Treatment) In the case of *Activated Sludge*, the bacterial culture refers to the group of *Bacteria* classified as *Aerobes*, and *Facultative* organisms, which covers a wide range of organisms. Most treatment processes in the United States grow facultative organisms which use the carbonaceous (carbon compounds) *Biochemical Oxygen Demand (BOD)*. Facultative organisms can live when oxygen resources are low. When “nitrification” is required, the nitrifying organisms are *Obligate Aerobes* (require oxygen) and must have at least 0.5 mg/L of dissolved oxygen throughout the whole system to function properly.

Bacterial Plate Count — A system used to quantify the number of bacteria in a sample of solid or liquid material by measuring the growth of bacterium into full colonies.

Bactericidal — Able to kill bacteria.

Bactericide — A substance that destroys bacteria.

Bacteriostatic — A substance that inhibits bacterial growth but is not necessarily lethal.

Badlands — Barren land characterized by roughly eroded ridges, peaks, and mesas.

Baffle — A flat board or plate, deflector, guide, or similar device constructed or placed in flowing water or slurry systems to cause more uniform flow velocities to absorb energy and to divert, guide, or agitate liquids (water, chemical solutions, slurry).

Bag of Waters — The double-walled fluid-filled sac that encloses and protects the fetus in the womb and that breaks releasing its

fluid during the birth process

Bail — To remove water, as from the bottom of a boat or other vessel.

Bailer — (1) **Bailer** — A 10- to 20-foot-long pipe equipped with a valve at the lower end. A bailer is used to remove slurry from the bottom or the side of a well as it is being drilled. (2) An instrument such as a long pipe with a valve at the lower end used to extract a water sample from a groundwater well. Also used to remove slurry from the bottom or side of a well as it is being drilled.

Bajada — (1) A long outwash detrital (sedimentary) slope at the base of a mountain range. (2) A broad, continuous alluvial slope or gently inclined detrital surface, extending along and from the base of a mountain range out into and around an inland basin, formed by the lateral coalescence of a series of separate but confluent alluvial fans, and having an undulating character due to the convexities of the component fans. It occurs most commonly in semiarid and desert regions, as in the southwestern United States. A bajada is a surface of deposition, as contrasted a pediment (a surface of erosion that resembles a bajada in surface form), and its top often merges with a pediment.

Balanced Operation — Operation of a canal system where the water supply exactly matches the total flow demand.

Balanced Groundwater Scenario (BGS) — A term referring to the development of a scenario exploring changes in cropping patterns such that long-term groundwater withdrawals do not exceed long-term groundwater recharge rates. Also see *Agricultural Restructuring Scenario (ARS)*, *Groundwater Overdraft*, and *Groundwater Mining*.

Ball Cock — A self-regulating device controlling the supply of water in a tank, cistern, or toilet by means of a float connected to a valve that opens or closes with a change in water level.

Ball Valve — A valve regulated by the position of a free-floating ball that moves in response to fluid or mechanical pressure.

Ballast — Heavy material, often seawater, placed in the hold of a ship to gain stability. Periodic discharges of this ballast water from oil tankers constitute a significant portion of the oil introduced into the oceans of the world each year.

Ballast Water [USCG] — Water that is taken on to or discharged from a ship as it loads or unloads its cargo, to accommodate changes in its weight. A modern cargo ship can carry from 100,000 to 10,000,000 gallons or more of ballast water. More than 21 billion gallons of ballast water are discharged in U.S. waters each year. In addition to water quality issues, this ballast water can contain living organisms taken up in a port half way around the world, which can invade the area where the water is discharged. In order to reduce the risk of species invasions from ballast water, the U.S. Coast Guard (USCG) has instituted a *Ballast Water Management Program*, which sets guidelines and requirements for ships to follow when taking up or discharging ballast water.

Ballast Water Management Program [USCG] — A water management program conducted by the U.S. Coast Guard (USCG) to comply with the National Invasive Species Act of 1996 which established both regulations and guidelines to control the invasion of *Aquatic Nuisance Species (ANS)*. The program recognizes that *Ballast Water* from ships is one of the largest pathways for the intercontinental introduction and spread of ANS. Ballast Water Management Practices are applicable to all vessels equipped with ballast water tanks that enter into the waters of the United States after operating beyond the Exclusive Economic Zone (EEZ). Principal program components consist of:

- Exchange ballast water beyond the EEZ, from an area more than 200 nautical miles from any shore, and in waters more than 2,000 meters in depth;
- Retention of the ballast water on board the vessel;
- Use an alternative environmentally sound method of ballast water management that has been approved in advance by the Commandant of the U.S. Coast Guard;
- Discharge ballast water to an approved reception facility; or
- Exchange ballast water in other waters approved by the USCG Captain of the Port.

Ballena — A major landform comprising distinctively round topped ridgeline remnants of fan alluvium. The ridge's broadly rounded shoulders meet from either side to form a narrow crest and merge smoothly with the concave backslopes. In ideal examples, the slightly concave footslopes of adjacent ballenas merge to form a smoothly rounded drainageway.

Balling — A method of hydraulically cleaning a sewer or storm drain by using the pressure of a water head to create a high cleansing velocity of water around the ball. In normal operation, the ball is restrained by a cable while water washes past the ball at high velocity. Special sewer cleaning balls have an outside tread that causes them to spin or rotate, resulting in a "scrubbing" action of the flowing water along the pipe wall.

Banco — A meander, oxbow lake, or other part of a stream channel or flood plain that has been cut off and left dry by a change in the course of a stream or a river.

Bank, and Banks — The slope of land adjoining a body of water, especially adjoining a river, lake, or a channel. With respect to flowing waters, banks are either right or left as viewed facing in the direction of the flow. As *Banks*, a large elevated area of a sea floor.

Bank and Channel Stabilization — Implementation of structural features along a streambank to prevent or reduce bank erosion and channel degradation.

Bank Storage — (1) Water that has been absorbed and retained in the permeable material which forms the banks and bed of a stream. (2) The water absorbed into the banks of a stream, lake, or reservoir, when the stage rises above the water table in the bank formations, then returns to the channel as effluent seepage when the stage falls below the water table. Bank storage may be returned in whole or in part as seepage back to the water body when the level of the surface water returns to a lower level. Also referred to as *Lateral Storage*.

Bankfull — The water level, or stage, at which a stream, river or lake is at the top of its banks and any further rise would result in water moving into the flood plain.

Bankfull Channel — The stream channel that is formed by the dominant discharge, also referred to as the active channel, which meanders across the floodplain as it forms pools, riffles, and point bars.

Bankfull Discharge — See *Dominant Discharge*.

Bankfull Stage — The stage at which a stream first begins overflows its natural banks. More precisely, an established river stage at a given location along a river which is intended to represent the maximum safe water level that will not overflow the river banks or cause any significant damage within the river reach. Bankfull stage is a hydraulic term, whereas *Flood Stage* implies resultant damage.

Banking (Water) — See *Water Banking*.

Baptism — (1) A Christian sacrament marked by ritual use of water and admitting the recipient to the Christian community; (2) A non-Christian rite using water for ritual purification.

Bar — (1) A sand or gravel deposit found on the bed of a stream that is often exposed during low-water periods. An accumulation of sand, gravel, or rock in the river channel or along the banks. (2) An elongated landform generated by waves and currents, usually running parallel to the shore, composed predominantly of unconsolidated sand, gravel, stones, cobbles, or rubble and with water on two sides. (3) A component landform comprised of elongate, commonly curving, low ridges of well sorted sand and gravel that stand above the general level of a *Bolson* floor and were built by the wave action of a Pleistocene lake. (4) A unit of pressure equal to 10^6 dynes per cm^2 , 100 kilopascals, or 29.53 inches of mercury.

Bar Racks — (Water Quality) The closely spaced rods, often in the form of a screen, that remove large solids from the wastewater entering a sewage treatment plant.

Bar Screen — (Water Quality) In wastewater treatment, a device used to remove large solid materials.

Barbed Tributary — A stream that forms a sharp bend pointing upstream as it joins the main flow in an upstream direction.

Barite — Natural finely ground barium sulfate used for increasing the density of drilling fluids.

Barothermograph — An instrument which records simultaneous barometric pressure and temperature on the same chart.

Barrage — An artificial obstruction, such as a dam or an irrigation channel, built in a watercourse to increase its depth or to divert its flow either for navigation or irrigation. Sometimes the purpose is to control peak flow for later release.

Barrel — (1) A measure of liquid volume (conventionally) equal to 42 U.S. gallons (34.9723 Imperial gallons), or 158.9873 liters. (2) Any of various units of volume or capacity. In the U.S. Customary System, it varies, as a liquid measure, from 31 to 42 U.S. gallons (approximately 120 to 159 liters) as established by law or usage.

Barrier Bar — An elongate ridge of sand and gravel which parallels the coast and is submerged at least at high tide.

Barrier Ice — The ice that makes up the Antarctic ice shelf. See *Shelf Ice*.

Barrier Lake — (1) A lake or other body of water that is retained or enclosed by a natural dam or barrier, such as a landslide or ice dam. (2) A freshwater lagoon that is separated from its lake by a sandbank or shore dune.

Bartlett Decree [Nevada] — The Bartlett Decree was issued on January 2, 1931 by Judge George A. Bartlett and adjudicated water rights along the Humboldt River and its tributaries. In addition to adjudicating the river system's water rights, this decree also recognized that the surface waters within the Humboldt River system were already fully appropriated, leaving no surplus water for irrigation during an average, or normal water year. Another important finding of the Bartlett Decree recognized the differences in growing seasons between the Humboldt River's upper basin and its lower basin and therefore divided the river system into two districts, District No. 1 below Palisade (USGS gaging station 10322500) and District No. 2 above Palisade. The Bartlett Decree also recognized the seasonal and ephemeral nature of many streams within the Humboldt River Basin through the concept of "flash streams" and the special need to accommodate water appropriators along such stream systems. These water courses were defined as streams "that have a sudden or flash flow or flush flow for a comparatively brief period of time, while such stream is draining the particular basin or source of supply fed by melting snows...These flash streams in varying degrees are typical of the necessity of cumulating the flow during the flush for the particular rights to be served. Where lands are entitled to irrigation from such flash streams, they must be served at the times when the water is available." The Bartlett Decree established three classes of lands with different irrigation requirements (water duties) and irrigation periods (both with respect to the number of days of allowable irrigation and the specific periods of irrigation). These irrigable land classes included: (1) Harvest crop lands (Class A) – all lands devoted to cultivated crops, including irrigated native or other grass lands which normally receive sufficient water to produce a crop which will justify cutting for hay, although it may sometimes be pastured and not cut; (2) Meadow pasture lands (Class B) – all grass lands free from brush which receive sufficient water to produce what may be classed as good pasture, but not sufficient to warrant cutting for hay; and (3) Diversified pasture lands (Class C) – all lands from which the brush has not been cleared but which are artificially irrigated to some extent for the production of grasses for pasturage. Further, the irrigation periods within the Humboldt River system varied by both the class of the land and whether it was in District No. 1 (below Palisade) or District No. 2 (above Palisade). Due to extensive review and corrections of the written findings by Judge Bartlett, the final Bartlett Decree would not be entered until October 20, 1931. The Bartlett Decree was subsequently modified by the *Edwards Decree*. With respect to adjudication of the Humboldt River, also see *Carville Decree*.

Basal Groundwater — A major body of groundwater that floats on and is in equilibrium with a body of salt water.

Basal Water Table — The water table of a body of unconfined *Basal Groundwater*.

Basalt — (Geology) (1) A fine-grained, dark-colored igneous rock which is generally of extrusive origin. (2) A dark volcanic rock composed of microscopic grains of augite, feldspar, and olivine. Some basalts have many holes that give the rock a swiss-cheese-like appearance. As the lava cools, gases escape, leaving holes of different sizes. (3) A general term for dark-colored iron- and magnesium-rich igneous rocks, common in extrusive, but locally intrusive rock formations. It is the principal rock type making up the ocean floor.

Basalt Aquifers — Aquifers found in basalt rock in areas of past volcanic activity, particularly in the Pacific Northwest region of the United States and in Hawaii.

Base — (1) Any of various typically water-soluble and bitter tasting compounds that in solution have a pH greater than 7, are capable of reacting with an acid to form a salt, and are molecules or ions able to take up a proton from an acid or able to give up an unshared pair of electrons to an acid. (2) Chemicals that release hydroxide ions (OH^-) in solution. Such solutions have a soapy feel, neutralize acids, and conduct electricity.

Base Exchange — The displacement of a cation bound to a site on the surface of a solid, as in silica-alumina clay-mineral packets, by a cation in solution.

Base Extra Capacity Method — A cost allocation method used by water utilities to determine water rates for various water user groups. This method considers base costs (Operations and Maintenance expenses and capital costs), extra capacity costs (additional costs for maximum day and maximum hour demands), customer costs (meter maintenance and reading, billing, collection, accounting) and fire protection costs.

Base Flood (100-Year Flood) — The flood having a 1 percent average probability of being equaled or exceeded in a given year at a designated location. It may occur in any year or even in successive years if the hydrologic conditions are conducive for flooding. Also see *Hundred-Year Flood*, *X-Year Flood*, and *X-Year Flood, Y-Duration Rain*.

Base Flood (FEMA) — A term used in the *National Flood Insurance Program (Federal Emergency Management Agency)* to indicate the minimum size flood to be used by a community as a basis for its floodplain management regulations; presently required by regulation to be that flood which has a one-percent chance of being equaled or exceeded in any given year. Also known as a *100-Year Flood* or *One-Percent Chance Flood*.

Base Flood Elevation (BFE) — (1) The height in relation to mean sea level (MSL) expected to be reached by the waters of the *Base Flood* at specific points in the floodplain of *Riverine* areas. (2) The elevation for which there is a one-percent chance in any given year that flood levels will equal or exceed it. (3) The elevation shown on the Flood Insurance Rate Map (FIRM) for Zones AE, AH, A1-A30, AR, AR/A, AR/AE, AR/A1-A30, AR/AH, AR/AO, V1-V30, and VE that indicates the water surface elevation resulting from a flood that has a 1-percent or greater chance of being equaled or exceeded in any given year. The BFE is generally based on statistical analysis of stream flow records for the watershed and rainfall and runoff characteristics in the general region of the watershed, and application of hydraulic backwater models.

Base Floodplain — The floodplain that would be inundated by a *One-Percent Chance Flood (100-Year Flood)*.

Base Flow — (1) The regular, steady, or fair-weather flow of water into stream channels. (2) The flow that a perennially flowing stream reduces to during the dry season. It is supported by groundwater seepage into the channel. (3) The fair-weather or sustained flow of streams; that part of stream discharge not attributable to direct runoff from precipitation, snowmelt, or a spring. Discharge entering streams channels as effluent from the groundwater reservoir. (4) The portion of river surface flow which remains after deduction of storm flow and/or purchased imported water. (5) The volume of flow in a stream channel that is not derived from surface run-off. Base flow is characterized by its flow regime (frequency, magnitude, and duration daily, seasonally, and yearly), by minimum low flow events and in context of the size and complexity of the stream and its channel.

Base Level — (1) The elevation to which a stream-channel profile has developed. (2) The lowest level to which a land surface can be reduced by the action of running water.

Base Load — The average minimum electrical demand on an electric generating facility, hydropower plant, or system of such facilities.

Base Metal — A metal (such as iron) which reacts with dilute hydrochloric acid to form hydrogen. Also see *Noble Metal*.

Base Period — A period of time specified for the selection of data for analysis. The base period should be sufficiently long to contain data representative of the averages and deviations from the averages that must be expected in other periods of similar and greater length. For example, the U.S. Weather Bureau computes values of average, heavy, and light monthly precipitation from data observed during the base period of 1931–1960. For ground-water studies, the base period should both begin and end at the conclusion of a dry trend so that the difference between the amount of water in transit in the soil at the ends of the base period is minimal.

Base Runoff — (1) Runoff that represents the natural flow of a stream, including that delayed by slow movement through lakes or swamps. Also referred to as *Fair-weather Runoff* or *Substantial Runoff*. (2) Sustained or fair weather runoff. In most streams, base runoff is composed largely of ground-water effluent. The term base flow is often used in the same sense as base runoff. However, the distinction is the same as that between streamflow and runoff. When the concept in the terms base flow and base runoff is that of the natural flow in a stream, base runoff is the more appropriate term.

Base Width — (1) The time interval between the beginning and end of the direct runoff produced by a storm. (2) The time period covered by a *Unit Hydrograph*.

Baseline — The condition that would prevail if no action were taken.

Baseline (Data) — A quantitative level or value from which other data and observations of a comparable nature are referenced. Information accumulated concerning the state of a system, process, or activity before the initiation of actions that may result in changes.

Basic — Describing a solution, sediment, or other material that has a pH greater than 7.0.

Basic Equilibrium Concept — The theory that everything in the universe depends on everything else.

Basic Hydrologic Data — Includes inventories of features of land and water that vary only from place to place (e.g., topographic and geologic maps), and records of processes that vary with both place and time (e.g., records of precipitation, streamflow, ground-water, and quality-of-water analyses). *Basic Hydrologic Information* is a broader term that includes surveys of the water resources of particular areas and a study of their physical and related economic processes, interrelations and mechanisms.

Basic Solution — Water solution with more hydroxide ions (OH^-) than hydrogen ions (H^+); a water solution with a pH greater than 7.

Basin — (1) A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often

natural or man-made lakes. Also referred to as *Drainage Basin*, *Watershed*, or *Hydrographic Region*. See *Basins [Nevada]*. (2) (Irrigation) A level plot or field, surrounded by dikes, which may be flood irrigated. (3) (Erosion Control) A catchment constructed to contain and slow runoff to permit the settling and collection of soil materials transported by overland and rill runoff flows. (4) (Nautical) A naturally or artificially enclosed harbor for small craft, such as a yacht basin.

Basin and Range [Nevada] — A region of north-trending mountains ranges and valleys encompassing western Utah and essentially all of Nevada. This geologic territory includes virtually all of the *Great Basin* and extends south and east through Arizona, New Mexico, and Texas all the way into Mexico. The Basin and Range can be differentiated from its surrounding geologic regions by its uplifted and tilted ranges separated by broad elongated basins. The Great Basin forms a unique part of this geologic region in as much as this hydrologic area has no drainage to the ocean.

Basin Cleaning Device (BCD) — A continuous clean-out system for removing the clogging layer that accumulates on the bottoms and sides of deep *Recharge Basins* and inhibits *Percolation*.

Basin Fill — Unconsolidated material such as sand, gravel, and silt eroded from surrounding mountains and deposited in a valley.

Basin Floor — A generic term for the nearly level, lowermost major physiographic part of intermontane basins, i.e., of both *Bolsons* and semi-bolsons. The floor includes all of the alluvial, eolian, and erosional landforms below the piedmont slope.

Basin-Floor Remnant — A flattish topped, erosional remnant of any former landform of a basin floor that has been dissected following the incision of an axial stream.

Basin Lag — (1) The time from the centroid (centermost point in time based on total period rainfall) of rainfall to the hydrograph peak. (2) The time from the centroid of rainfall to the centroid of the *Unit Hydrograph*.

Basin Management (of Water) — Also referred to as *Water or Watershed Management*, it is the analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of man. Basin management for water production is concerned with the quality, quantity, and timing of the water which is produced.

Basin of Origin — The area (hydrographic region or area) from in surface waters naturally occur or from which groundwater is removed.

Basin Yields — The amount of water which will flow from a drainage or catchment area in a given storm.

Basins [Nevada] — The U.S. Geological Survey (USGS) and the Nevada Division of Water Resources, Department of Conservation and Natural Resources, have divided the state into discrete hydrologic units for water planning and management purposes. These have been identified as 232 *Hydrographic Areas* (256 areas and sub-areas, combined) within 14 major *Hydrographic Regions* or *Basins*. These 14 Nevada Hydrographic Regions (Basins), along with the approximate surface areas (Nevada only), counties of coverage, extension into adjoining states, and number of hydrographic areas and sub-areas are:

- [1] **Northwest Region** – Covers 3,052 square miles (7,905 square kilometers or 1,953,280 acres) of northern Washoe and Humboldt counties and encompasses 16 hydrographic areas; also extends into the State of California to the west and the State of Oregon to the north;
- [2] **Black Rock Desert Region** – Covers 8,632 square miles (22,357 square kilometers or 5,524,480 acres) of parts of Washoe, Humboldt, and Pershing counties and includes 17 valleys (hydrographic areas), two of which are divided into two hydrographic sub-areas each; also extends into the State of California to the west and the State of Oregon to the north;
- [3] **Snake River Basin** – Covers 5,230 square miles (13,546 square kilometers or 3,347,200 acres) in parts of Elko and Humboldt counties to include eight hydrographic areas; also extends into the states of Oregon and Idaho to the north and the State of Utah to the east;
- [4] **Humboldt River Basin** – Covers over 16,843 square miles (43,623 square kilometers or 10,779,520 acres) in parts of eight counties – Elko, White Pine, Eureka, Humboldt, Lander, Nye, Pershing, and Churchill – and the largest stream (Humboldt River) wholly within Nevada. This basin contains 34 hydrographic areas and one hydrographic sub-area; this basin is one of only two that are wholly contained within the State of Nevada;
- [5] **West Central Region** – Covers 1,656 square miles (4,289 square kilometers or 1,059,840 acres) and includes parts of Pershing, Lyon, and Churchill counties and comprises five hydrographic areas; this basin is one of only two that are wholly contained within the State of Nevada;
- [6] **Truckee River Basin** – Encompasses 2,300 square miles (5,957 square kilometers or 1,472,000 acres) containing parts of Washoe, Pershing, Churchill, Lyon, Douglas, Carson City, and Storey counties comprising 12 hydrographic areas; has its origin to the west in the State of California;
- [7] **Western Region** – Covers 602 square miles (1,559 square kilometers or 385,280 acres) and is wholly contained in Washoe County and contains nine valleys (hydrographic areas) one of which is divided into two sub-areas and another divided into one hydrographic sub-area; also extends to the west into the State of California;
- [8] **Carson River Basin** – Covers 3,519 square miles (9,114 square kilometers or 2,252,160 acres) and includes parts of six counties – Douglas, Carson City, Lyon, Storey, Churchill, and Pershing – containing five hydrographic areas and one hydrographic sub-area along the Carson River and its tributaries; has its origin to the west in the State of California;
- [9] **Walker River Basin** – Covers 3,046 square miles (7,889 square kilometers or 1,949,440 acres) of Mineral, Lyon, and Douglas counties (and a very small portion of Churchill County) including five hydrographic areas, one of which has been divided into three hydrographic sub-areas; has its origin to the west in the State of California;
- [10] **Central Region** – By far the largest hydrographic region in Nevada covering 46,783 square miles (121,167 square kilometers or 29,941,120 acres) in 13 counties – Nye, Elko, White Pine, Lincoln, Clark, Humboldt, Pershing, Churchill, Lander, Eureka, Lyon, Mineral, and Esmeralda. This region includes 78 valleys (hydrographic areas),

- 10 of which are divided into two hydrographic sub-areas and one into three hydrographic sub-areas; extends to the south and west into the State of California;
- [11] **Great Salt Lake Basin** – Covers 3,807 square miles (9,860 square kilometers or 2,436,480 acres) of the easternmost portions of Elko, White Pine, and Lincoln counties. It consists of eight hydrographic areas, one of which is divided into four hydrographic sub-areas; extends to the east into the State of Utah;
 - [12] **Escalante Desert Basin** – This basin covers a large area in Utah but only a very small part of it is in Lincoln County – 106 square miles (275 square kilometers or 67,480 acres) – and is made up of only one hydrographic area; extends to the east into the State of Utah;
 - [13] **Colorado River Basin** – Covers 12,376 square miles (32,054 square kilometers or 7,920,640 acres) including parts of Clark, Lincoln, Nye, and White Pine counties and is divided into 27 hydrographic areas; extends to the south into the State of California, borders the Colorado River to the east and south, and extends into the states of Arizona and Utah to the east;
 - [14] **Death Valley Basin** – Covers 2,593 square miles (6,716 square kilometers or 1,659,520 acres) of Nye and Esmeralda counties including eight hydrographic areas, one of which has been divided into two hydrographic sub-areas; extends into the State of California to the south and west.

Basophilous — (Ecology) Living or thriving in alkaline habitats. Derivative term includes *Basophily*.

BAT — See *Best Available Technology*.

Batch Process — (Water and Wastewater Treatment) A treatment process in which a tank or reactor is filled, the wastewater (or other solution) is treated or a chemical solution is prepared, and the tank is emptied. The tank may then be filled and the process repeated. Batch processes are also used to cleanse, stabilize or condition chemical solutions for use in industrial manufacturing and treatment processes.

Bath — The act of soaking or cleansing a body, as in water or steam. Also, the water used for such cleansing.

Bathe — (1) To take a bath or go into the water for swimming or other recreation. (2) To become immersed in or as if in liquid; to seem to wash or pour over; suffuse.

Batholith — A mass of *Igneous* rock that forms intrusively and can rise to the surface.

Bathing Water — Water in swimming pools or natural fresh or marine waters used for swimming.

Bathometer — An instrument used to measure the depth of water.

Bathub Effect — The accumulation of *Leachate* in a landfill containing a good liner, but not equipped with a leachate collection and removal system.

Bathyal Zone — The ocean stratum beneath the *Euphotic Zone* and above the *Abyssal Zone*, or to the bottom of the *Continental Shelf*. The density of life in this zone depends on organic material settling from the euphotic zone and is generally inversely proportional to the depth.

Bathymetric Map — A map showing the depth of water in lakes, streams, or oceans.

Bathymetry — (1) The measurement of the depth of large bodies of water. (2) The measurement of water depth at various places in a body of water. Also the information derived from such measurements.

Bathyscaphe — A free-diving, self-contained deep-sea research vessel consisting essentially of a large flotation hull with a crewed observation capsule fixed to its underside, capable of reaching depths of 10 kilometers (6.2 miles) or more.

Bathysphere — A reinforced spherical deep-diving chamber in which persons are lowered by a cable to study the oceans. The bathysphere, limited to depths of about 900 meters (3,000 feet), has been supplanted by the safer and more navigable *Bathyscaphe*.

Bathythermograph — An instrument designed to record water temperature as a function of depth.

Baumé — Being, calibrated in accordance with, or according to either of two arbitrary hydrometer scales for liquids lighter than water or for liquids heavier than water that indicate specific gravity in degrees.

Bay — A part of a sea or lake, indenting the shoreline; a wide inlet not so large as a *Gulf*.

Bay-Delta [California] — Refers to the region encompassing the Sacramento-San Joaquin river delta system forming a basically delta or triangular structure extending from south Sacramento in the north to below Stockton in the south to the San Francisco Bay in the west. Before the Bay-Delta was extensively altered by human activity it was an immense wetlands that supported an abundant array of birds, fish, and wildlife. One early explorer described the area as “nothing more than a wide and extended lawn, exuberant in wild oats and a place for wild beasts to lie down in – the deer, antelope and noble elk... The wild geese, and every species of water fowl darkened the surface of every bay and firth.” The Bay-Delta is the largest remaining *Estuarine* system on the West Coast of the United States. The Bay-Delta estuary is a mixing zone of fresh and salt water and its unique environment supports diverse plant, fish, and animal life. The Delta is the state’s most important fishery habitat. An estimated 25 percent of all warm water and anadromous sport fish and 80 percent of the state’s commercial fishery live or migrate through the Delta. The Bay-Delta contains approximately 738,000 total acres (1,153 square miles) interlaced with hundreds of miles of water waterways. Of this total area, 520,000 acres are in agriculture, 35,000 acres are contained in cities and towns, 50,000 acres are covered with water, and 133,000 acres remain undeveloped. The gross value of the Bay-Delta’s agricultural production totals over \$500 million per year. Deep water ship channels run through the Bay-Delta and connect both Sacramento and Stockton to the San Francisco Bay and the Pacific Ocean. As much of the Bay-Delta’s land area is up to 21 feet below the water level, waters flowing throughout this system are controlled by over 1,100 miles of levees. Rivers flowing into the Bay-Delta include the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras, which, along with their tributaries, carry 47 percent of California’s total surface runoff. The Bay-Delta serves as the major collection point for the water that serves over two-thirds of California’s total population. Along with associated pumping facilities, the Bay-Delta provides the source waters for a number of major water development projects to include the California Aqueduct, the Central Valley Project’s Delta-Mendota Canal, the

Contra Costa Canal, and the North and South Bay Aqueducts. Within the Bay-Delta system may be found extensive populations of fauna and flora to include 230 species of birds, 45 species of mammals, 52 species of fish, 25 species of reptiles and amphibians, and 150 species of flowering plants. Major *Anadromous* fish using the Bay-Delta include Salmon, Striped Bass, Steelhead Trout, American Shad, and Sturgeon. Also referred to as the *Sacramento-San Joaquin Delta* or more simply “The Delta”. Also see *Central Valley Project (CVP) [California]* and *State Water Project (SWP) [California]*.

Bayesian Inference — (Statistics) Bayes’ theorem recognizes that a decision maker usually has some expectation (an *a priori* model) of what will occur even before acquiring information, and provides a procedure for using new evidence to produce a revised *a posteriori* estimate of probability. Also see *Statistical Inference* and *Classical Inference*.

Bayou — (1) A marshy inlet, outlet, or arm of river or lake in flat country, usually sluggish or stagnant due to floods and lack of drainage. (2) An estuarial creek or inlet. (A Louisiana French word believed to be derived from the Choctaw word “bayuk.”) (3) In general, a creek, secondary watercourse, or minor river, tributary to another river or other body of water. A term regularly used in the lower Mississippi River basin and in the Gulf-coast region of the United States to denote a large stream or creek, or small river, characterized by a slow or imperceptible current through alluvial lowlands or swamps. May also refer to an estuarial creek or inlet on the Gulf Coast; a small bay, open cove, or harbor; also, a lagoon, lake or bay, as in a sea marsh or among salt-marsh islands.

Beach — (1) A sloping landform on the shore of larger water bodies, generated by waves and currents and extending from the water to a distinct break in landform or substrate type (e.g., a foredune, cliff, or bank.) (2) A generic term for offshore bars, barrier bars, and beach terraces. (3) To run a ship up onto a beach or shore.

Beach Erosion — The carrying away of beach materials by wave action, tidal currents, or littoral currents, or by wind.

Beach Plain — A major landform of *Bolson* floors comprised of numerous, closely spaced offshore bars and intervening lagoons built by a receding Pleistocene lake.

Beach Platform — See *Wave-Cut Bench*.

Beach Pool — (1) A small, usually temporary body of water between two beaches or two beach ridges. (2) A pool adjoining a lake, formed by wave action from the lake.

Beach, Public — Beach dedicated by a governmental body to the common use of the public, which the unorganized public and each of its members have a right to use while it remains so designated.

Beach Terrace — A component landform occurring on the lower piedmont slope that consists of a wave-cut scarp and a wave-built terrace of well sorted sand and gravel marking a still-stand of a Pleistocene lake.

Bead — A small, round object, especially a drop of moisture, as beads of sweat.

Beaded Lake — A narrow lake between sand dunes. Also see *Paternoster Lake*.

Beaufort’s Scale — (Meteorology) A scale devised by Sir F. Beaufort, Royal Navy, in 1805, in which the strength of the wind is indicated by numbers from 0 to 12. The corresponding terms are: calm [0], light air [1], light breeze [2], gentle breeze [3], moderate breeze [4], fresh breeze [5], strong breeze [6], moderate gale [7], fresh gale [8], strong gale [9], whole gale [10], storm [11], hurricane [12]. Also see *Wind Scale*.

Bed — (1) The bottom of a body of water, such as a stream. (2) An underwater or intertidal area in which a particular organism is established in large numbers. (3) (Geology) A rock mass of large horizontal extent bounded, especially above, by physically different material (as in *Bedrock*).

Bed Load — (1) Sediment particles up to rock, which slide and roll along the bottom of the streambed. (2) Material in movement along a stream bottom, or, if wind is the moving agent, along the surface. (3) The part of the total stream load that is moved on or immediately above the stream bed, such as the larger or heavier particles (boulders, pebbles, gravel) transported by traction or saltation along the bottom; the part of the load that is not continuously in suspension or solution. (4) The sediment that is transported in a stream by rolling, sliding, or skipping along or very close to the bed. In USGS reports, bed load is considered to consist of particles in transit from the bed to an elevation equal to the top of the bed-load sample nozzle (usually within 0.25 feet of the streambed). Contrast with material carried in *Suspension* or *Solution*.

Bed Load Discharge — The quantity of sediment, typically measured in tons per day, that is moving as bed load, reported as dry weight, that passes a cross section in a given time.

Bed Material — The sediment mixture of which a streambed, lake, pond, reservoir, or estuary bottom is composed.

Bed Slope — The inclination of the channel bottom.

Bedding — (Geology) A term which signifies the existence of beds (strata) of laminate in rocks which are generally of sedimentary origin.

Bedew — To wet with or as if with *Dew*.

Bedrock — (Geology) (1) Continuous solid rock that outcrops at the surface locally but generally is overlain by unconsolidated material. (2) Any geologic formation or sediment of Pliocene age or older. (3) The solid rock beneath the soil (*Zone of Aeration* or *Zone of Saturation*) and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material.

Bedscarp (Nick Point) — An abrupt change in grade in the bottom of a stream channel that moves progressively upstream; the change in grade forms a waterfall. Also, the location where a streambed is actively eroding downward to a new base level.

BEE — Bioenvironmental Engineer(ing).

Beheaded Stream — (1) A stream whose upper part has been cut off and diverted into the channel of another stream that has greater erosional activity and that flows at a lower level. (2) The lower section of a stream that has lost its upper portion through diversion or *Stream Piracy*.

Bell — A hollow, usually inverted vessel, such as one used for diving deep below the surface of a body of water.

Below — Down river from a point or viewing location.

Belt — (1) A long strip of pack ice whose width may range from 1 to 100 kilometers (0.6 to 62 miles) or more. (2) (Ecology) Any definable strip or area of vegetation. (3) (Geography) An often elongated zone having distinctive characteristics.

Belt of Soil Moisture — Subdivision of the *Zone of Aeration*. Belt from which water may be used by plants or withdrawn by soil evaporation. Some of the water passes down into the intermediate belt, where it may be held by molecular attraction against the influence of gravity.

Bench — A name applied to ledges that are shaped like steps or terraces cut into the side of hills in the removal of coal.

Bench Flume — A flume built on constructed benches or terraces along hillsides or around mountain slopes when the ground is too rough or too steep to permit the use of an excavated canal.

Bench Land (Soils) — A general term describing porous and coarse-textured (sandy-gravelly) well-drained soils, overlying a deep water table (if occurring), that exhibits relatively low water holding capacity and rapid infiltration of irrigation water.

Bench Lands [Nevada] — The U.S. Department of the Interior, Bureau of Reclamation criteria (revised 1992) has defined *Bottom Land* for Nevada's *Newlands Irrigation Project*, located in Churchill County, Nevada, as "those lands with a five-foot soil profile having a holding capacity equal to or exceeding 8 inches and/or a water table within 6 feet of the surface for a period equal to or exceeding 150 days. If neither of these factors apply, the land is designated as *Bench Land*." Lands classified as bench (or bottom) according to Bureau of Reclamation criteria, above, will be limited to maximum water deliveries (duty) in accordance to the provision of the *Orr Ditch Decree* and the *Alpine Decree*, which are identical in establishing water duties and establish the following limits: (1) Eligible lands designated as *Bench Lands* may receive a maximum of 4.5 acre-feet per acre per year (AF/acre/year); (2) eligible lands designated as *Bottom Lands* may receive a maximum of 3.5 acre-feet per acre per year (AF/acre/year).

Bench Mark (Benchmark) — (1) A permanent marker which designates a point of known elevation. (2) Data used as a base for comparative purposes with comparable data.

Bench Scale Analysis — A method of studying different ways of treating wastewater and solids on a small scale in a laboratory.

Bending — The first stage in ice deformation, in which lateral pressure produces an upward or downward motion in sea ice.

Beneficial Use (of Water) — (1) The amount of water necessary when reasonable intelligence and diligence are used for a stated purpose. (2) A use of water resulting in appreciable gain or benefit to the user, consistent with state law, which varies from one state to another. (3) Any use of water within or outside the state, that is reasonable and useful and beneficial to the *Appropriator*, and at the same time is consistent with the interests of the public of this state in the best utilization of water supplies. Most states recognize the following uses as beneficial:

- [1] domestic and municipal uses;
- [2] industrial uses;
- [3] irrigation;
- [4] mining;
- [5] hydroelectric power;
- [6] navigation;
- [7] recreation;
- [8] stock raising;
- [9] public parks;
- [10] wildlife and game preserves.

(4) The cardinal principle of the *(Prior) Appropriation Doctrine*. A use of water that is, in general, productive of public benefit, and which promotes the peace, health, safety and welfare of the people of the State. A certificated water right is obtained by putting water to a beneficial use. The right may be lost if beneficial use is discontinued. A beneficial use of water is a use which is of benefit to the *Appropriator* and to society as well. The term encompasses considerations of social and economic value and efficiency of use. In the past, most reasonably efficient uses of water for economic purposes have been considered beneficial. Usually, challenges have only been raised to wasteful use or use for some non-economic purpose, such as preserving instream values. Recent statutes in some states have expressly made the use of water for recreation, fish and wildlife purposes, or preservation of the environment a beneficial use. Also see *Appropriative Water Rights*.

Beneficial Uses — Desirable uses that water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support.

Benefit/Cost Analysis — A quantitative evaluation of the costs which would be incurred versus the overall benefits to society of a proposed action such as the establishment of an acceptable dose of a toxic chemical. Also referred to as *Cost/Benefit Analysis*.

Benefit-Cost Ratio — (1) The relationship of the economic benefits of an action to its total costs. (2) An economic indicator of the efficiency of a proposed project, computed by dividing benefits by costs; usually, both the benefits and the cost are discounted, so that the ratio reflects efficiency in terms of the present value of future benefits and costs.

Benthic — (1) The bottom of lakes or oceans. See *Benthic Region*. (2) Referring to organisms that live on the bottom of water bodies. See *Benthic Invertebrates* and *Benthic Organisms*.

Benthic Invertebrates — Aquatic animals without backbones that dwell on or in the bottom sediments of fresh or salt water. Examples are clams, crayfish, and a wide variety of worms.

Benthic Macroinvertebrate — An animal lacking a backbone or internal skeleton which lives on or near the bottom of a body of water (for example, crayfish, mayflies, and nymphs). Because they spend their entire lifecycle in water, they are good indicators of the health of that waterbody.

Benthic Organisms — Those organisms living at or near the bottom of a body of water. They include a number of types of organisms, such as bacteria, fungi, insect larvae and nymphs, snails, clams, and crayfish. They are useful as indicators of water

quality. See *Indicator Species*. Also see *Benthic Invertebrates*.

Benthic Region — The bottom of a body of water, supporting the *Benthos*.

Benthos — (1) All the plant and animals living on or closely associated with the bottom of a body of water. (2) Organisms living within a stream's substrate.

Bentonite — (1) A clay material that swells as it dries, filling gaps and sealing itself against a well casing. (2) A clay formed from the decomposition of volcanic ash. Bentonite commonly has great ability to absorb water and to swell accordingly. It is usually white to light green in color, but light blue when fresh. (3) A highly plastic, colloidal clay composed largely of the mineral montmorillonite, a hydrated aluminum silicate. It is commonly used to seal abandoned dewatering wells at mines. Concrete, by contrast, shrinks as it cures, and can therefore leave gaps around a wellhead casing that can allow contaminated water from the surface to penetrate into the well.

Bentonite Grout — A mixture consisting of a high solids, sodium bentonite material, approved by the chief engineer, which has been commercially manufactured and specially formulated for use as a well casing seal or to plug a borehole or abandoned well.

Berg — A mass of floating or stationary ice; and *Iceberg*.

Bergeron Process — The process by which ice crystals in a cloud grow at the expense of supercooled liquid water droplets.

Bergschrund — (Geology) A deep gap or crevasse, or a series of closely spaced fissures, formed at or near the head of a mountain glacier or snowfield and separating the moving ice or snow from the relatively stationary ice and snow. Also referred to as *Shrund*.

Bernoulli Effect — The phenomenon of internal pressure reduction with increased stream velocity in a fluid. Named after Daniel Bernoulli.

Bernoulli's Equation — Under conditions of steady flow of water, the sum of the velocity head, the pressure head, and the head due to elevation at any given point is equal to the sum of these heads at any other point plus or minus the head losses between the points due to friction or other causes.

Berm — (1) A narrow ledge or path as at the top or bottom of a slope, stream bank, or along a beach. (2) (Dam) A horizontal step or bench in the upstream or downstream face of an *Embankment Dam*.

Betrunked River — A river whose lower course has been removed by the submergence of a valley or by the recession of the coast.

Betrunking — The disappearance of the lower part of a stream course as a result of the submergence of a valley or the recession of a coast, thus causing the upper branches of the stream system to enter the seas as smaller, independent streams.

Best Available Demonstrated Technology (BADT) — The level of effluent limitation technology required by the 1972 *Clean Water Act (CWA)* to be used in setting new source performance standards for new industrial direct dischargers of water pollutants.

Best Available Technology (BAT) — The best technology treatment techniques, or other means which the EPA Administrator finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are available (taking cost into consideration). For the purposes of setting minimum contaminant levels (MCLs) for synthetic organic chemicals, any BAT must be at least as effective as granular activated carbon.

Best Available Technology Economically Achievable — A national goal under the *Water Pollution Control Act* of 1972 (*Public Law 92-500*, commonly referred to as the *Clean Water Act*) which provides that industry shall use the best treatment technically and economically achievable for a category or class of point sources. Under this concept, pollution control will consider such factors as the age of the facilities and equipment involved, processes employed, engineering aspects of the control techniques, process changes, cost of the reductions, and environmental impacts other than water quality, including energy requirements.

Best Conventional Control Technology (BCT) — The level of water pollution control technology required of existing dischargers for the treatment of conventional pollutants by the 1977 *Clean Water Act (CWA)*.

Best Management Practices (BMP) — (1) A generally accepted practice for some aspect of natural resources management, such as water conservation measures, drainage management measures, or erosion control measures. Typically incorporates conservation criteria. (2) Structural, nonstructural and managerial techniques that are recognized to be the most effective and practical means to accomplish a given requirement, but are not requirements themselves. (3) Activities, practices or prohibitions of practices, maintenance procedures and other management practices to prevent or reduce the pollution of waters of the United States. These practices are identified by industry. (4) A set of field activities that provide the most effective means for reducing pollution from a nonpoint source. (5) An engineered structure or management activity, or combination of these, that eliminates or reduces an adverse environmental effect of a pollutant. (6) Accepted methods for controlling *Non-Point Source (NPS) Pollution* as defined by the 1977 *Clean Water Act (CWA)*; may include one or more conservation practices. Also refers to water conservation techniques of proven value. See, for example, *Best Management Practices (BMP) – Urban Water Use*.

Best Management Practices (BMP) – Urban Water Use — Water conservation measures that generally meet one of two criteria: (1) Constitutes an established and generally accepted practice among water purveyors that provides for the more efficient use of existing water supplies or contributes towards the conservation of water; or (2) Practices which provide sufficient data to clearly indicate their value, are technically and economically reasonable, are environmentally and socially acceptable, are reasonably capable of being implemented by water purveyors and users, and for which significant conservation or conservation-related benefits can be achieved. Some of the most significant of the urban water use BMPs include:

- Interior and exterior water audits and incentive programs for single family residential, multi-family residential, commercial, industrial, and government and institutional users;
- New and retrofit plumbing;
- Distribution system water audits, leak detection, and repair;
- Metering with commodity rates for all new connections and retrofit of existing connections;
- Large landscape water audits and incentives;
- Landscape water conservation requirements for new and existing commercial, industrial, institutional,

- government, and multi-family residential development projects;
- Public information and awareness programs;
- Water education programs for teachers and schools;
- Commercial and industrial water conservation programs;
- New commercial and industrial water use review;
- Conservation pricing—increasing block rates;
- Landscape water conservation for new and existing single family homes;
- Water waste prohibition, enforcement, and fines;
- Water conservation coordinator;
- Financial incentives;
- Ultra-low flush toilet and showerhead replacement programs.

In addition to these proven Best Management Practices, there are a number of other actions that may be taken to further encourage water conservation and more efficiently utilize water resources. These constitute *Potential Best Management Practices* and may include the following:

- Rate structures and other incentives and disincentives to discourage frivolous water use and encourage water conservation;
- Efficiency standards for water using appliances and irrigation devices;
- Replacement of existing water using appliances (except toilets and showerheads whose replacements are incorporated as Best Management Practices) and irrigation devices;
- Retrofit of existing car washes;
- Graywater use;
- Distribution system pressure regulation;
- Water supplier billing records broken down by customer class (e.g., residential, commercial, industrial, agricultural, etc.);
- Commercial billing records broken down by industry classification (Standard Industrial Classification [SIC] Codes);
- Swimming pool and spa conservation including covers to reduce evaporation;
- Restrictions or prohibitions on devices that use evaporation to cool exterior spaces (e.g., mist sprayers);
- Use of point-of-use hot water heaters, recirculating hot water systems, and hot water pipe insulation;
- Efficiency standards for new industrial and commercial processes.

For comparison, see *Efficient Water Management Practices (EWMP)*, *Agricultural Water Use*.

Best Practicable Control Technology (BPT) — A national goal under the *Water Pollution Control Act* of 1972 (*Public Law 92-500*, or the *Clean Water Act*) which provides that industry shall use the best treatment practices practical, with due consideration to cost, age of the plant and equipment, and other factors.

Bias — (1) An inadequacy in experimental design that leads to results or conclusions not representative of the population under study. (2) An error in data gathering or analysis caused by faulty program design, mistakes on the part of personnel, or limitations imposed by available instrumentation or data sources.

Bicarbonate — (Water Quality) A compound containing the HCO_3^- group, for example, sodium bicarbonate (NaHCO_3), which ionizes in solution (water) to produce HCO_3^- . Also see *Carbonate* and *Carbonate Buffer System*.

Biennial Plant — A plant that lives for two years, producing vegetative growth the first year, usually blooming and fruiting in the second year, and then dying.

Bifurcate — Dividing structure which splits the flow of water.

Bifurcation Ratio — A measure of the degree of stream branching within a drainage basin and equal to the ratio of the number of streams of any given order to the number of streams of the next higher order.

Big Water — Large volume of flowing water with a fast current, big waves, and often accompanied by huge *Reversals* and extreme general turbulence. The terms big water and *Heavy Water* are closely similar, but big water carries stronger connotations of an immense volume and extreme violence.

Bight — (1) A crescent-shaped indentation formed in an ice edge by currents or winds. (Geology) (2) A long, gradual bend or gentle curve in a shoreline that forms an open coast or bay. (3) A bend or curve in a river or in a mountain chain.

Bilge Water — Water that collects and stagnates in the bilge or bottom-most areas of a ship.

Billabong — (Australian) (1) A dead-end channel extending from the main stream of a river. (2) A streambed filled with water only in the rainy season. (3) A stagnant pool or backwater. (4) A term referring to a channel leading from a river to a dry stream bed that may be filled seasonally, or to a long, stagnant pool that is the result of a temporary stream overflow.

Billow — A large wave or swell of water.

Bimodal Distribution — (Statistics) A collection of observations with a large number of values centered (as in a *Normal Distribution*) around each of two points. For example, in a sampling of the heights of a population, the sample results would tend to be concentrated around an average heights for males and a second average height for females.

Bioaccumulants — Substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted. Also see *Biological Magnification*.

Bioaccumulation — (1) The retention and concentration of a substance by an organism. (2) The increase in concentration of a chemical in organisms that reside in environments contaminated with low concentrations of various organic compounds. Also used to describe the progressive increase in the amount of a chemical in an organism resulting from rates of absorption of a

substance in excess of its metabolism and excretion. (3) The build-up of a pollutant within the tissues of a living organism to concentrations much higher than the surrounding environment. This usually occurs as predators eat large numbers of prey each having a small amount of a pollutant in their body.

Bioassay — (1) A test which determines the effect of a chemical on a living organism. (2) A method for quantitatively determining the concentration of a substance by its effects on the growth of a suitable animal, plant, or microorganism under controlled conditions.

Biochemical Oxidation — The process by which bacteria and other microorganisms feed on complex organic materials and decompose them. Self-purification of waterways and activated sludge and trickling filter wastewater treatment processes depend on this principle.

Biochemical Oxygen Demand (BOD) — (1) The amount of oxygen consumed by microorganisms (mainly bacteria) and by chemical reactions in the *Biodegradation* of organic matter. (2) A measure of the quantity of dissolved oxygen, in milligrams per liter, necessary for the decomposition of organic matter by microorganisms, such as bacteria. (3) The oxygen required for the biochemical degradation of organic material (carbonaceous) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. In other words, a measure that indicates the degree to which dissolved oxygen levels would change in a river or stream based on the contributions of organic matter. (4) The quantity of dissolved oxygen, measured in milligrams per liter (or parts per million) required during the stabilization of decomposable organic matter content by aerobic biochemical action. This quantity is determined by diluting a sample with water saturated with oxygen and measuring the dissolved oxygen in the mixture both immediately and after a five-day incubation period. (5) A measure of the amount of oxygen removed from aquatic environments by aerobic micro-organisms for their metabolic requirements. Measurement of BOD is used to determine the level of organic pollution of a stream or lake. The greater the BOD, the greater the degree of water pollution. Also referred to as *Biological Oxygen Demand (BOD)*.

Biochemical Oxygen Demand (BOD) Loading — (Water Quality) The BOD content, commonly expressed in pounds/day, of wastewater passing into a waste treatment system or a body of water. The greater the BOD content, the greater the degree of pollution.

Biochemistry — The science dealing with the chemistry of living matter.

Biochores — Divisions of the *Biosphere*.

Biocide — A chemical substance that kills living organisms. Typically used to include materials that can kill desirable as well as undesirable organisms.

Bioclimatic — Of or pertaining to the effects of climate on living organisms. See *Bioclimatic Zones*.

Bioclimatic Zones — Also referred to as *Biomes*, these constitute the earth's ten zones differentiated by climate, soil, water, and plant and animal life. See *Biome*.

Bioclimatology — (Ecology) The study of the relationship between climate and the activities and characteristics of plants and animals. Also referred to as *Bioclimatics*.

Biocoenosis — A community of animal and plant life.

Bioconcentration — (1) The process by which an individual organism directly concentrates a substance from the surrounding air, water, or soil. (2) The accumulation of a chemical in tissues of an organism (such as fish) to levels that are greater than the level in the medium (such as water) in which the organism resides. (3) The increase in concentration of a chemical in an organism resulting from absorption levels exceeding the rate of metabolism and excretion. Also see *Bioaccumulation*.

Bioconcentration Factor (BCF) — Used to describe the accumulation of chemicals in aquatic organisms that live in contaminated environments. Also see *Bioconcentration*.

Bioconcentration Potential (BCP) — The maximum concentration of a chemical in an organism resulting from the rate of absorption equaling the rate of metabolism and excretion.

Bioconversion — The conversion of organic materials, such as plant or animal waste, into usable products or energy sources by biological processes or agents, such as certain microorganisms.

Biodegradable — (1) An organic substance that is quickly broken down by normal environmental processes. (2) Capable of being decomposed by biological agents or microorganisms, especially bacteria. The property of a substance that permits it to be broken down by microorganisms into simple, stable compounds such as carbon dioxide and water.

Biodegradation — (1) The metabolic breakdown of materials into simpler components by living organisms. (2) Decomposition of a substance into more elementary compounds by the action of microorganisms such as bacteria. A more specific form of Biotransformation. Also see *Phytoremediation* and *Rhizodegradation*.

Biodenitrification — The controlled use of microbes, usually bacteria, to reduce level of nitrates (NO_3^-) and thereby reclaim contaminated water or wastewater. The process consists of several stages to decompose the nitrates first into nitrites and then into nitrogen gas, N_2 . Upon entering the treatment process, sodium sulfite (Na_2SO_3) is added as a reducing agent to the wastewater to remove the oxygen from the water. To break down the nitrates, the bacteria must have a carbon food source and typically ethanol is added for the bacteria to feed on. In order to survive, however, the bacteria need oxygen which they obtain by breaking down the nitrate ions, first to nitrite and then to harmless nitrogen gas. Also referred to as *Endogenous Respiration*.

Biodisc — (Water Quality) A large rotating cylinder possessing surface features that allow for the growth of attached microorganisms. The cylinder revolves and contacts the wastewater along one side while the other side is exposed to air, thereby maximizing the oxygenation of the water and stimulating decomposition of dissolved or suspended organic material.

Biodiversity — (1) The variety of life and its processes. Biodiversity includes the diversity of landscapes, communities, and populations (genetic variation). Also called *Biological Diversity* or *Biotic Diversity*. (2) Refers to the variety and variability of life, including the complex relationships among microorganisms, insects, animals, and plants that decompose waste, cycle nutrients, and create the air that we breathe. Diversity can be defined as the number of different items and their relative

frequencies. For biological diversity, these items are organized at many levels, ranging from complete *Ecosystems* to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes. It is generally accepted that human survival is dependent upon the conservation and preservation of this diversity of life forms. Typically five levels of biodiversity are recognized:

- [1] **Genes** – Genetic diversity encompasses the variety of genetically coded characteristics of plant and animal populations;
- [2] **Populations** – Groups of individuals of a species that interbreed or interact socially in an area;
- [3] **Species** – The level at which most organisms are recognizable as distinct from all others;
- [4] **Natural Communities** – Groups of species that typically occur in recognizable units, such as redwood forests, coastal sage scrub, or oak woodlands. A natural community includes all the vegetation and animal life, and their interactions within that community; and
- [5] **Ecosystems** – A collection of natural communities. An ecosystem can be as small as a rotting log or a puddle of water, but current management efforts typically focus on larger landscape units, such as a mountain range, a river basin, or a watershed.

Biodiversity Measures — A means to measure and quantify the current status of biological diversity in terms of past evolutionary developments, biogeographic processes, extinctions, and current influences. Typically considered in such measures are the number and type of rare, threatened, and endemic species, extinctions and extirpations, population structure (i.e., panmictic, meta-populations, isolated populations), and the presence and impacts of non-native species. Ecosystems can be viewed as comprised of three distinct but related elements: components, structures, and processes. Components are the kinds and amounts of plants, animals, soils, water, etc. Structures refers to spatial distribution or pattern (vertical or horizontal) of components. Processes refer to the flow or cycling of energy, materials, and nutrients through space and time. These terms for ecosystem elements are useful in identifying and distinguishing measures of biological diversity and their interconnections. Some of the more prominent measures of biological diversity are listed below:

Taxonomic Diversity – The number of representatives at each taxonomic level (e.g., genera, family, order, phyla, kingdom). This measure provides an index of genetic diversity.

Trophic Diversity – The diversity (richness and evenness) of species within each trophic level (primary producer, primary consumer, secondary consumer, tertiary consumer, decomposer, detritivore). The flow or cycling of energy follows along food webs. Organisms within a food web are associated with a trophic level which can be defined as all the organisms that have the same basic life strategy as defined by the number of levels away from the original source of energy (i.e., the sun). This measure provides an index of the diversity of processes.

Life Strategy Diversity – Diversity (richness and evenness) of species employing each resource use strategy (food resources used (insectivorous, granivorous, omnivorous, saprophytic, herbivorous, carnivorous) breeding strategy, general habitat associations). This measure provides another index of the diversity of processes.

Ecological Function Diversity – Diversity (richness and evenness) of species associated with each of several ecological functions (e.g., nitrogen availability, plant pollination, nutrient cycling, sedimentation, soil aeration). This measure provides an index of the diversity of processes.

Species Diversity – Shannon-Weiner diversity index based on richness and evenness of species. It is the most commonly used measure of biological diversity, and the Shannon-Weiner diversity index is the most widely used metric for this measure.

Species Richness by Rarity Class – The proportion of rare species or communities present (based on known or likely presence within the basin) by rarity class (i.e., rare: occur only in some watersheds; uncommon: >1 in most watersheds; common: many representatives in all or most watersheds). This measure provides information on the distribution of abundances across species which, when compared with historical accounts, offers an index of the trend of biological diversity in the area at the species/population scale of the biological dimension.

Plant Community Diversity – Diversity (richness and evenness) of riparian plant communities by type (forest, wet meadow, dry meadow, shrub). This measure provides an index of diversity at the community/ecosystem scale of the biological dimension.

Endemism – Number of endemic species (and their abundance) at each taxonomic level and by species group (e.g., birds). This measure provides an index of genetic diversity and biome/biogeography diversity, and when compared with historical accounts provides an index of general trends in biological diversity.

Exotic Species Load – Proportion of exotic to native species, and the number and prevalence of exotic species stratified by their relative magnitude of impact on native species by impact class (i.e., low: no known negative impact on native species; moderate: known negative impact on some native species, but no known threat to distribution; high: known negative impact on some native species and known threat to distribution or reproductive success). This measure provides some information on one of the primary factors affecting biological diversity, and when compared with historical accounts can serve as an index of past and potential future trends in biological diversity at the community/ecosystem scale.

Biodynamics — The branch of biology dealing with energy or the activity of living organisms.

Bioecology — The study of the interrelations between plants and animals and their environment.

Bioelectricity — Of or pertaining to electric phenomena occurring in plants and animals.

Biofloculation — (Wastewater Treatment) The clumping together of fine, dispersed organic particles by the action of certain bacteria and algae. This results in faster and more complete settling of the organic solids in wastewater.

- Biofouling** — (1) The gradual accumulation of waterborne organisms (as bacteria and protozoa) on the surfaces of engineering structures in water that contributes to corrosion of the structures and to a decrease in the efficiency of moving parts. (2) The formation of bacterial film (biofilm) on fragile reverse osmosis membrane surfaces.
- Biogas** — Methane gas produced during the *Anaerobic* decomposition of the remains of plants or animal wastes by bacteria.
- Biogenesis** — The production of living organisms from other living organisms.
- Biogenic** — Used to describe changes in the environment resulting from the activities of living organisms.
- Biogeochemical Cycling** — The flow of chemical substances to and from the major environmental reservoirs: *Atmosphere*, *Hydrosphere*, *Lithosphere*, and *Biosphere*. As chemicals move in the cycle, they often change chemical form, usually existing in a characteristic form in each reservoir. As an example, carbon (in the lithosphere) exists mainly as carbon dioxide in the atmosphere, carbonic acid, bicarbonate, or the carbonate ion when dissolved in water (hydrosphere), and as more complex organic compounds in animals and plants (biosphere).
- Biogeochemistry** — (1) The science dealing with the relation of earth chemicals to plant and animal life. (2) The science dealing with the relationship between the geochemistry of a given region and its flora and fauna. (3) The study of the transformation and movement of chemical materials to and from the *Lithosphere*, the *Atmosphere*, the *Hydrosphere*, and the bodies of living organisms (the *Biosphere*).
- Biogeography** — The study of the geographic distribution of organisms.
- Biohydrology** — (Ecology) The study of the interaction between plant and animal life and the water cycle.
- Bioindicator** — A living organism that denotes the presence of a specific environmental condition. For example, the presence of coliform bacteria identifies water that is contaminated with human fecal material.
- Biological Activated Carbon (BAC) Process** — The combination of *Ozonation* and *Granular Activated Carbon (GAC)* for the removal of dissolved organics, particularly *Dissolved Organic Carbon (DOC)* from drinking water. This water treatment method has seen more widespread use in Europe primarily due to: (1) the generally poorer quality of surface waters there; (2) the greater concern and more stringent standards for chlorination byproducts; and (3) the strict aesthetic demand of European consumers. Also referred to as the *Biologically Enhanced Activated Carbon Process*.
- Biological Additives** — Cultures of bacteria, enzymes, or nutrients that are introduced into an oil discharge or other wastes to promote decomposition.
- Biological Amplification** — An increase in concentration of DDT, PCBs, and other slowly degradable, fat-soluble chemicals in organisms at successively higher trophic levels of a food chain or web. Also see *Biological Magnification*.
- Biological Assessment** — (1) An evaluation of the biological condition of a waterbody that uses biological surveys and other direct measurements of resident biota in surface waters. (2) Biological assessments are evaluations of the condition of waterbodies using surveys and other direct measurements of resident biological organisms (*Macroinvertebrates*, fish, and plants). Biological assessment results are used to answer the question of whether waterbodies support survival and reproduction of desirable fish, shellfish, and other aquatic species, specifically intended to determine if the waterbodies meet their designated aquatic life uses.
- Biological Community** — All of the living things in a given environment.
- Biological Control** — The direct human introduction of living organisms – predators, parasites, or pathogens – to eliminate or control undesirable species. The practice is usually considered an ecologically sound alternative to the application of chemical pesticides.
- Biological Criteria** — Numeric values or narrative expressions that describe the reference biological condition of aquatic communities inhabiting waters that have been given a designated aquatic life use.
- Biological Diversity** — The number and kinds of organisms per unit area of volume; the composition of species in a given area at a given time.
- Biological Growth** — The activity and growth of any and all living organisms.
- Biological Indicators** — Plant or animal species or communities with a narrow range of ecological tolerance that may be selected for emphasis and monitored because their presence and relative abundance serve as a barometer of ecological conditions within a management unit.
- Biological Integrity** — (1) The condition of the biological components (usually *Benthic Macroinvertebrates* and/or fish) of a waterbody. The integrity condition is generally based on a comparison to a reference which is a relatively undisturbed system and represents the best quality to be expected for the *Ecoregion*. (2) The condition of the aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota. Three critical components of biological integrity are that the biota: (a) represents the product of the evolutionary process for that locality, or site; (b) is inclusive of a broad range of biological and ecological characteristics such as taxonomic richness and composition, trophic structure; and (c) is found in the study biogeographic region.
- Biological Magnification** — (Ecology) (1) An increasing concentration of toxic substances within each successive link of the food chain. Also referred to as *Biological Amplification* and *Biomagnification*. (2) Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the chain. Also see *Bioaccumulants* and *Bioaccumulation*.
- Biological Monitoring** — The use of a biological entity as a detector and its response as a measure to determine environmental conditions. Toxicity tests and biological surveys are common biological monitoring methods.
- Biological Opinion** — A document which states the opinion of the *U.S. Fish and Wildlife Service (USFWS)* as to whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.
- Biological Oxidation** — Decomposition of complex organic materials by microorganisms. Occurs in the self-purification of water bodies and in activated sludge wastewater treatment processes.

Biological Oxygen Demand (BOD) — (1) The amount of oxygen required to stabilize decomposable matter by aerobic action. (2) (Water Quality) An indirect measure of the concentration of biologically degradable material present in organic wastes. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic waste. Also see *BOD5*. Also referred to as *Biochemical Oxygen Demand (BOD)*.

Biological Processes — Processes characteristic of, or resulting from, the activities of living organisms.

Biological Survey (also Biosurvey) — The process of collecting, processing, and analyzing representative portions of a resident aquatic assemblage to determine the assemblage structure and function.

Biological Treatment — A treatment technology that uses bacteria to consume organic wastes.

Biological Wastewater Treatment — The use of bacteria to degrade and decompose organic materials in wastewater.

Biology — (1) The science of life and of living organisms, including their structure, function, growth, origin, evolution, and distribution. It includes *Botany* and *Zoology* and all their subdivisions. (2) The life processes or characteristic phenomena of a group or category of living organisms. (3) The plant and animal life of a specific area or region.

Bioluminescence — The production of light by living organisms.

Biolysis — Dissolution of a living organism.

Biomagnification — The process by which a substance is passed up the food chain resulting in an especially high level of the substance at upper levels of the food chain. A biological process wherein a contaminant's concentration increases at each level up the food chain, including humans. Thus, the availability of such contaminants, even in the seemingly insignificant parts per trillion range, often are ecologically important. See *Biological Magnification*.

Biomass — (1) The total mass of living matter within a given unit of environmental area, typically expressed as mass per unit area or volume of habitat. (2) That part of a given habitat consisting of living matter, expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat. (3) Organic matter produced by plants and other photosynthetic producers; total dry weight of all living organisms that can be supported at each trophic level in a food chain; dry weight of all organic matter in plants and animals in an ecosystem; plant materials and animal wastes used as fuel. (4) Plant material, vegetation, or agricultural waste used as a fuel or energy source. Some methods of determining biomass in a sample include:

- [1] **Ash Mass** — The mass or amount of residue present after the residue from the dry mass determination has been ashed in a muffle furnace at a temperature of 500EC for 1 hour. The ash mass values of zooplankton and phytoplankton are expressed in grams per cubic meter (g/m^3), and periphyton and benthic organisms in grams per square mile (g/mi^2).
- [2] **Dry Mass** — The mass of residue present after drying in an oven at 105EC for zooplankton and periphyton, until the mass remains unchanged. This mass represents the total organic matter, ash and sediment, in the sample. Dry-mass values are expressed in the same units as ash mass.
- [3] **Organic Mass or Volatile Mass** — Refers to the mass of a living substance as the difference between the dry mass and ash mass and represents the actual mass of the living matter. The organic mass is expressed in the same units as for the ash mass and dry mass.
- [4] **Wet Mass** — The mass of living matter plus contained water.

Biomass Pigment Ratio — An indicator of the total proportion of periphyton which are autotrophic (plants). Also referred to as the *Autotrophic Index*.

Biomat — (1) (Hydraulics) A term used in subsoil hydraulics to describe a clogging layer of typically densely packed decaying organic matter which impedes the downward flow of water. (2) (Water Quality) A restrictive layer that develops beneath the distribution lines of the *Soil Absorption System (SAS)* of *Septic Tanks* at the gravel-soil or bed-soil interface. As the *Septic Tank Effluent (STE)* is not suitable for direct discharge into surface waters or onto land surfaces because of the presence of biodegradable organics and high bacterial content that may include *Pathogens*, the effluent typically undergoes further purification by three processes: absorption, filtration, and microbiological decomposition. The biomat constitutes a clogging mat, *Anaerobic* in nature, characterized as a black slimy layer, and composed of accumulated suspended solids, minerals, bacterial cells, microorganism fragments, polysaccharides, and polyuronides. The biomat is extremely active biologically and helps ensure the conditions for optimal treatment of the effluent by restricting the infiltration rate into the soil, inducing unsaturated soil conditions and reducing the chances of high dispersion below the system. Biomats are also highly effective in removing bacterial and pathogens from the STE and can also detain viruses that can be present in the effluent. Also referred to as *Biocrust*, *Clogging Mat*, and *Clogging Zone*.

Biome — (Ecology) (1) A complex of communities characterized by a distinctive type of vegetation and maintained under the climatic conditions of the region. (2) A recognizable complex biotic community of a given region, produced by the interaction of climatic factors, living organisms, and substrate; especially a community that has developed to climax vegetation, such as tundra, coniferous forest, or grassland. (3) A major regional or global *Biotic* community of plants and animals whose composition is determined by soil and the prevailing climate. The earth is characterized by ten *Bioclimatic Zones* or *Biomes* which consist of:

- [1] **Tundra** — treeless areas between the icecap and the tree line of Arctic regions, having a permanently frozen subsoil and supporting low-growing vegetation such as lichens, mosses, and stunted shrubs.
- [2] **Taiga** — the subarctic, evergreen coniferous forests of northern Eurasia located just south of the tundra and dominated by firs and spruces.
- [3] **Temperate Forest** — forested areas characterized by deciduous plants and moderate temperatures, weather, or climate.

- [4] **Grassland** – areas, such as a prairie or meadow, of grass or grasslike vegetation.
- [5] **Savanna** – flat grasslands of tropical or subtropical regions.
- [6] **Desert** – barren or desolate areas, especially dry, often sandy regions of little rainfall, extreme temperatures, and sparse vegetation.
- [7] **Montane** – cool, moist zones usually located near the timberline and usually dominated by evergreen trees.
- [8] **Tropical Rain Forest** – dense evergreen forests occupying a tropical region typically with an annual rainfall of at least 2.5 meters (100 inches).
- [9] **Tropical Dry Forest** – tropical or subtropical forests similar to tropical rain forests excepting that many of the plant species are deciduous and there exists a well-defined dry season.
- [10] **Islands** – land masses, especially ones smaller than a continent, entirely surrounded by water.

Biometeorology — (Ecology) The study of the effects on living organisms of both natural and artificial atmospheric phenomena, such as temperature, humidity, barometric pressure, rate of air flow, and air ionization.

Biometrics — The application of mathematical-statistical theory to biology.

Biomonitoring — The use of living organisms to test the suitability of an effluent for discharge into receiving waters or to test the quality of such receiving waters downstream from the discharge. Also see *Bioassay*.

Bionics — The study of how man and animals perform certain tasks and solve certain problems, and of the application of the findings to the design of computers and other electronic equipment.

Bioremediation — (1) Simply, the use of biological techniques to clean up pollution. More specifically, the use of specialized, naturally-occurring micro-organisms with unique biological characteristics, appetites, and metabolisms as a form of waste cleanup. A critical underpinning of this process is the ability to economically generate a sufficient biomass of the appropriate microbes to accomplish in weeks or months what would normally take nature years to do. Typically, this is done either by applying a sufficient concentration of such microbes directly to the polluted area or by applying various concentrations of chemicals which, in turn, stimulate and foster the rapid growth of appropriate micro-organisms. (2) A process of adding nutrient to groundwater to speed up the natural process in which bacteria break down gasoline into harmless compounds.

Biosocial — Of or pertaining to social phenomena that are affected by biological factors.

Biosolids — A nutrient-rich organic material resulting from the treatment of wastewater. Biosolids contain nitrogen and phosphorus along with other supplementary nutrients in smaller doses, such as potassium, sulfur, magnesium, calcium, copper and zinc. Soil that is lacking in these substances can be reclaimed with biosolids use. The application of biosolids to land improves soil properties and plant productivity, and reduces dependence on inorganic fertilizers. The terms biosolids, *Sludge*, and *Sewage Sludge* can be used interchangeably.

Biosphere — (1) The part of the earth's crust, waters, and atmosphere where living organisms can subsist. (2) In its broadest sense, the entire planetary ecosystem including all living organisms and those parts of the earth and its atmosphere in which living organisms exist or that are capable of supporting life, to include, in addition to the plant and animal species:

- [1] **Atmosphere** – the gaseous layer covering the earth;
- [2] **Lithosphere** – the solid portion of the earth's crust and mantle; and
- [3] **Hydrosphere** – that portion of the earth composed of liquid water.

Also referred to as the *Ecosphere*. In a more restrictive sense, may also refer to only the living organisms on earth and not to their physical and chemical environments.

Biosurvey — (Wastewater Treatment) A survey of the types and numbers of organisms naturally present in the receiving waters upstream and downstream from plant effluents. Comparisons are made between the aquatic organisms upstream and those organisms downstream of the discharge to determine the effectiveness and compliance with the treatment processes.

Biosynthesis — The formation, by synthesis or degradation, of chemical compounds by a living organism.

Biota — (1) All the flora and fauna of a given area; plants, animals and other living resources of a region. (2) The plant and animal life of a region or ecosystem, as in a stream or other body of water.

Biotechnical Slope Protection — A process involving the use of live and dead woody cuttings and poles or posts collected from native plants to revegetate watershed slopes and stream banks. The cuttings, posts, and vegetative systems composed of bundles, layers, and mats of the cuttings and posts provide structure, drains, and vegetative cover to repair eroding and slumping slopes. Also referred to as *Soil Bioengineering*.

Biotechnology — The use of microorganisms, such as bacteria or yeasts, or biological substances, such as *Enzymes*, to perform specific industrial or manufacturing processes. Applications include the production of certain drugs, synthetic hormones, and bulk foodstuffs as well as the *Bioconversion* of organic waste and the use of genetically altered bacteria in the cleanup of oil spills and other hazardous materials.

Biotic — Pertaining to life or living things, or caused by living organisms.

Biotic Community — (1) A naturally occurring assemblage of plants and animals that live in the same environment and are mutually sustaining and interdependent. (2) A group of interacting organisms within a given area. Plant communities are characterized by a distinctive physiognomy or appearance, such as woodland or forest. At a regional scale, the biotic community is called a *Biome* (e.g., the western coniferous forest biome).

Biotic Integrity — The ability of a community to recover and maintain system processes within historic variability.

Biotic Potential — The capacity of a population animals or plants to increase in numbers under optimum environmental conditions.

Biower — (Water Quality) A means of wastewater treatment in which the waste is allowed to fall through a tower packed with synthetic media, on which there is biological growth. Similar to a trickling filter in concept.

Biotransformation — Conversion of a substance into other compounds by organisms. A more general form of *Biodegradation*.

Biotype — A group of organisms having the same hereditary characteristics.

Bilvolume — See *Cells Volume*.

Bittern — The bitter water solution of bromides, magnesium, and calcium salts remaining after sodium chloride is crystallized out of seawater.

Bivalves — A mollusk, such as an oyster, clam, or scallop, that has a shell consisting of two hinged halves. As a *Filter Feeder*, such marine animals are frequently excellent *Bioindicators* for water quality conditions.

Black Alkali — Dark-colored incrustation encountered on some arid-region soils containing organic materials dissolved by the carbonate solutions of sodium and other metals. Evaporation of the solutions leaves the so-called black-alkali deposit.

Black Ice — (1) A thin, nearly invisible coating of ice, as on the surface of a road or sidewalk, that is usually caused by freezing mist and is extremely hazardous. (2) A thin layer of clear ice formed on land, freshwater, or saltwater, which appears dark because of its transparency. (3) Dark glacier ice formed by the freezing of salt water. Also see *Glaze*.

Black Smoker — A vent in a geologically active region of the sea floor from which issues superheated water laden with minerals (as sulfide precipitates).

Black Snow — A term for dark-colored snow that results from falling through a particulate-laden atmosphere.

Blackwater — (1) Liquid and solid human body waste and the carriage water generated through toilet and/or urinal usage. (2) Water that contains animal, human, or food wastes; wastewater from toilet, latrine, and aqua privy flushing and sinks used for food preparation or disposal of chemical or chemical-biological ingredients. Compare to *Greywater*.

Blanch — To scald or parboil in water or steam in order to remove the skin from, whiten, or stop enzymatic action in (as food for freezing).

Blank — A bottle containing only dilution water or distilled water; the sample being tested is not added. Tests are frequently run on a “Sample” and a “Blank” and the differences are compared.

Blanket (of a Dam) — A portion of the physical structure of a dam designed to affect the dam's hydrologic characteristics, particularly its seepage and strength characteristics. Types of dam blankets include:

- [1] **Drainage Blanket** — A drainage layer placed directly over the dam's foundation material;
- [2] **Grout Blanket** — The injection of grout to consolidate a layer of the foundation, resulting in greater impermeability and/or strength; and
- [3] **Upstream Blanket** — An impervious layer placed on the reservoir floor upstream of a dam; in the case of an Embankment Dam, the blanket may be connected to the impermeable element in the dam itself.

Blanket Bog — (Ecology) An extensive layer of peat over flat and rolling land, formed by bog vegetation and deriving its nutrients primarily from rainfall. Blanket bogs are typically found in cold, wet parts of the world. See *Bog*.

Blanket Mires — See *Peatland*.

Blar — To dim with water or tears.

Blending — The mixing or combination of one water source with another, typically a finished source of water with raw water to reuse water while still satisfying water quality standards, for example, mixing of product water from a desalting plant with conventional water to obtain a desired dissolved solids content, or mixing brine effluents with sewage treatment plant effluents in order to reduce evaporation pond size.

Blind — Describing a lake or pond that has no inflow or outflow.

Blind Creek — A creek that is dry except during rainfall. Also see *Closed Drainage*.

Blind Lake — A lake that has no flow of water either in or out.

Blinding — (Wastewater Treatment) The clogging of the filtering medium of a microscreen or a vacuum filter when the holes or spaces in the media become clogged or sealed off due to a buildup of grease or the material being filtered.

Blinds — Water samples containing a chemical of known concentration given a fictitious company name and slipped into the sample flow of the lab to test the impartiality of the lab staff.

Blizzard — A severe weather condition characterized by strong winds, snow (sometimes heavy), blowing and drifting snow and cold temperatures.

Bloom — (1) In aquatic ecosystems, the rapid growth or proliferation of algae, commonly referred to as *Algal Bloom* or *Algae Bloom*; often related to pollution, especially when pollutants accelerate growth. (2) Also a visible, colored area on the surface of bodies of water caused by excessive planktonic growth.

Blow Down (also Blowdown) — (1) The water drawn from boiler systems and cold water basins of cooling towers to prevent the buildup of solids. (2) The portion of a recirculated water stream, usually involved in an evaporation cycle such as in a steam boiler, which is run to waste to avoid accumulation of impurities.

Blowhole — (1) A hole in ice to which aquatic mammals, such as dolphins and seals, come to breathe. (2) An opening that passes through a snowbridge into a crevasse or system of crevasses that are otherwise sealed by snowbridges. (3) (Geology) A nearly vertical hole or natural chimney in the roof of a sea cave or a wave-formed tunnel, through which incoming waves and rising tides force air to rush upward or water to spout intermittently.

Blowing Snow — Snow lifted from the surface of the earth by the wind to a height of six feet or more above the surface (higher than drifting snow), and blown about in such quantities that horizontal visibility is restricted.

Blowout — (1) A sudden escape of a confined gas or liquid, as from a well. (2) An uncontrolled escape of drilling fluid, gas, oil, or water from the well caused by the formation pressure being greater than the hydrostatic head of the fluid in the hole. Also see *Sand Boil*.

Blue Band — A layer of relatively bubble-free glacier ice or a band marking the appearance of such a layer on the surface of a glacier.

Blue-Green Algae — A group of phytoplankton which often cause nuisance conditions in water, so called because they contain a blue pigment in addition to chlorophyll.

Blue Ice — (1) Pure, clear, coarse-grained glacier ice having a bluish to greenish color. (2) On the Antarctic ice sheet, an *Ablation Area* where bare glacier ice shows at the surface as a result of wind erosion.

Blue Water — The open sea.

BMP — See *Best Management Practices (BMP)* and *Best Management Practices (BMP) – Urban Water Use*.

BOB — To move up and down briefly or repeatedly, as in water.

BOD — See *Biochemical Oxygen Demand (Biological Oxygen Demand)*.

BOD5 — The amount of dissolved oxygen consumed in five days by biological processes breaking down organic matter. The total amount of oxygen used by microorganisms decomposing organic matter increases each day until the ultimate BOD is reached, usually in 50 to 70 days. Also see *Biological Oxygen Demand (BOD)*.

Body Fluid — the total body water, contained principally in blood plasma and in intracellular and interstitial fluids. Also see *Body Water Content*.

Body Water Content — That portion of the human body composed of water; expressed as a percentage of total body volume. Specifically, the human body is comprised of approximately 65–70 percent water: 67 percent of the water in the body is located within cells; 25 percent between cells; and the rest, about 8 percent, is located in the blood. If more than 8 percent of the body's water is lost, death will result.

Bog — (Ecology) (1) A wet, spongy swamp area made up of peat and decaying vegetable materials. A term frequently associated with *Wetlands*, bogs are poorly drained freshwater wetlands that are characterized by a build-up of peat. Sphagnum mosses are also frequently found in many bogs. (2) A quagmire filled with decayed moss and other plant and vegetable matter; wet spongy ground, where a heavy body is apt to sink; a small, soggy marsh; a morass. (3) (Ecology) A wet, overwhelmingly vegetative substratum which lacks drainage and where humic and other acids give rise to modifications of plant structure and function. Bogs depend primarily on precipitation for their water source, and are usually acidic and rich in plant residue with a conspicuous mat of living green moss. Only a restricted group of plants, mostly *mycorrhizal* (fungi, heaths, orchids, and saprophytes), can tolerate bog conditions. Also referred to as *Peat Bog*. Also see *Peatland*.

Bog Hole — A hole containing soft mud or quicksand.

Bog Lake — A small, bog-surrounded body of water with a false bottom of organic material and vegetation on a floating mat of peat.

Boil — (1) To change from a liquid to a vapor by the application of heat. Also see *Boiling Point*. (2) A water current upwelling into a convex mound.

Boilerplate — Frozen, crusty, hard-packed snow.

Boiling Point — The temperature at which the vapor pressure of a liquid is equal to the pressure exerted on the liquid. (Water) When the atmospheric pressure is 86 centimeters of mercury (sea level), the boiling point of water is, by definition, 100E Celsius (C) or 212E Fahrenheit (F). The boiling point decreases with elevation.

Boiling Spring — (1) A spring whose waters are agitated by heat action. (2) A rapidly flowing stream characterized by strong vertical eddies. (3) A stream rising from the bottom of a residual clay basin and located at the head of an interior valley.

Boiling Water Reactor (BWR) — A nuclear reactor in which water, used as both coolant and moderator, is allowed to boil in the core. The resulting steam can be used directly to drive a turbine generating electric power.

Boiloff — The vaporization of liquid.

Bolson — An alluvium-floored basin, depression, or wide valley, mostly surrounded by mountains and drained by a system that has no surface outlet; an undrained or an internally drained intermontane basin. Bolson fill is the alluvial *Detritus* that fills a bolson; also commonly called bolson deposits. Also see *Semi-Bolson*.

Bolson Floor — A specific identification for the floor of a bolson as compared with a *Semi-Bolson* floor.

Bong — A water pipe that consists of a bottle or a vertical tube partially filled with liquid and a smaller tube ending in a bowl, used often in smoking narcotic substances.

(Lake) Bonneville — See *Lake Bonneville*.

Boom — A floating device used to contain oil on a body of water.

Bonnet — The cover on a gate valve.

Borax — A white crystalline compound that consists of a hydrated sodium borate $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$, that occurs as a mineral or is prepared from other minerals, and that is used especially as a flux, cleansing agent, and water softener, as a preservative, and as a fireproofing agent.

Border — A soil berm 15 to 18 inches tall thrown up with a disk to keep flood irrigation water inside a given portion of the pasture.

Border Ditch — A ditch used as a border of an irrigated strip or plot, water being spread from one or both sides of the ditch along its entire length.

Border Irrigation — A surface method of irrigation by flooding between two confining border levees or dikes. Typically, these borders vary from 100 to 200 feet wide by 1,000 to 3,960 feet long.

Bore — A high, often dangerous wave caused by the surge of a flood tide upstream in a narrowing *Estuary* or by colliding tidal currents. Also referred to as an *Eagre*.

Boreal Forest — (Ecology) (1) A northern forest, as in the boreal forest *Biome*, characterized by evergreen conifers and long winters. The boreal forest, also referred to as a *Taiga*, is found in the northern parts of North America, Europe, and Asia. (2) A vast area of forest vegetation that lies adjacent to the arctic tundra, and stretches southward from the arctic timberline down to the north temperate forest; in North America it covers large areas of Canada and parts of the United States Northeast and upper Midwest.

Borehole — A hole bored or drilled in the earth, as an exploratory well; a small-diameter well drilled especially to obtain water.

Borrow Area (Pit) — The portion of land from which soil or rock is moved to another location, as for a dam or roadway.

Botany — The branch of *Biology* that studies plants, including their structure, function, growth, origin, evolution, and distribution.

Bottled Water — Water sold commercially generally for its health, therapeutic, or purity values. In the United States, bottled water is considered a food product and as such is regulated by the Food and Drug Administration (FDA). Beginning in May 1996, the FDA required all bottled waters to carry accurate labels: “spring water” must come from a spring; “mineral water” must carry a certain mineral content; “sterile” water must be processed to meet FDA standards for commercial sterility; and if water comes from municipal supplies, it must be labeled as such. See *Bottled Water [Food and Drug Administration]* and *Bottled Water [Nevada]*.

Bottled Water [Food and Drug Administration (FDA)] — As defined by the FDA [Department of Health and Human Services, Federal Register, Part III, 21 CFR Part 165, Subpart B—Requirements for Specific Standardized Beverages, effective May 13, 1996] bottled water is water that is intended for human consumption and that is sealed in bottles or other containers with no added ingredients except that it may optionally contain safe and suitable antimicrobial agents. Fluoride may be optionally added within certain specified limitations. Bottled water may be named bottled water, drinking water, or alternatively one of the following terms may be used as appropriate:

- [1] **Artesian Water or Artesian Well Water** – Water from a well tapping a confined aquifer in which the water level stands at some height above the top of the aquifer.
- [2] **Groundwater** – Water from a subsurface saturated zone that is under a pressure equal to or greater than atmospheric pressure; groundwater must not be under the direct influence of surface water.
- [3] **Mineral Water** – Water containing not less than 250 parts per million (ppm) total dissolved solids (TDS), coming from a source tapped at one or more bore holes or springs, originating from a geologically and physically protected underground water source; mineral water shall be distinguished from other types of water by its constant level and relative proportions of minerals and trace elements at the point of emergence from the source; no minerals may be added to this water. Mineral water containing less than 500 ppm TDS must be labeled “low mineral content”. Conversely, if the water has more than 1,500 ppm TDS, it must be labeled “high mineral content”.
- [4] **Purified Water** – Water that has been produced by distillation, deionization, reverse osmosis, or other suitable processes and that meets the definition of “purified water” in the *United States Pharmacopeia*. May also be called demineralized water, purified drinking water, or alternatively, based on the process used, deionized (drinking) water, distilled (drinking) water, reverse osmosis (drinking) water, etc.
- [5] **Sparkling Bottled Water** – Water that, after treatment and possible replacement of carbon dioxide, contains the same amount of carbon dioxide from the source that it had at emergence from the source.
- [6] **Spring Water** – Water derived from an underground formation from which water flows naturally to the surface of the earth; shall be collected only at the spring or through a bore hole tapping the underground formation feeding the spring.
- [6] **Sterile or Sterilized Water** – Water that meets the requirements under “Sterility Tests” in the *United States Pharmacopeia*.
- [7] **Well Water** – Water from a hole bored, drilled, or otherwise constructed in the ground which taps the water of an aquifer.

Other label statements for bottled water include “low mineral content” for TDS levels below 500 ppm, “high mineral content” for TDS levels above 1,500 ppm, or when the water comes from a community water system, it must be labeled “from a community water system,” or, alternatively, “from a municipal source.”

Bottled Water [Nevada] — According to Nevada Administrative Code (NAC) Chapter 445A, “Bottled Water,” effective November 1994, bottled water may be labeled and sold as:

- [1] **Distilled Water** – Water that is demineralized by distillation and complies with the requirements for purified water set forth in the *United States Pharmacopeia*.
- [2] **Drinking Water** – Water that is filtered and disinfected by a process approved by the health authority.
- [3] **Mineral Water** – Water that is clearly distinguishable from other types of water by its specific content of minerals and trace elements which remain constant at the water’s point of emergence; boreholes or springs from which mineral water is produced must originate from an underground source which is geologically and physically protected from contamination.
- [4] **Natural Water** – Water that is produced from a well (*Natural Well Water*) or an artesian well (*Natural Artesian Water*) and no minerals have been added or removed from the water; may be filtered and must be disinfected by a process approved by the health authority.
- [5] **Purified Water** – Water that is demineralized by distillation, deionization, or reverse osmosis and complies with the requirements for purified water set forth in the *United States Pharmacopeia*.
- [6] **Spring Water** – Water that is produced from a point at the surface where the water flows naturally from an underground formation or through a borehole adjacent to that point in a manner approved by the health authority.
- [7] **Municipal Water** – Water that is produced from a public water system; may be sold and labeled as distilled water, drinking water, purified water if it complies with specific filtration and disinfection requirements.

Bottom — (1) The deepest or lowest part, as the bottom of a well. (2) The solid surface under a body of water. (3) Often *Bottoms*: Low-lying alluvial land adjacent to a river, also referred to as bottomland. (4) (Nautical) The part of a ship’s hull below the water line.

Bottom Flow — A current flowing along the bottom of a body of water that is denser than any section of the surrounding water.

Bottom Land (also Bottomland) (Soils) — A general term describing generally rich, loamy or fine-textured and poorly drained

soils, overlying a shallow water table or possibly adjacent to a stream, lake or other body of water, that exhibits relatively good water holding capacity and slow to moderate infiltration of irrigation water; often associated with a river's floodplain.

Bottom Land Hardwoods — Forested freshwater *Wetlands* adjacent to rivers in the southeastern United States, especially valuable for wildlife breeding, nesting, and habitat.

Bottom Lands [Nevada] — The U.S. Department of the Interior, *Bureau of Reclamation (USBR)* criteria (revised 1992) has defined *Bottom Land* for Nevada's *Newlands Irrigation Project*, located in Churchill County, Nevada, as "those lands with a five-foot soil profile having a holding capacity equal to or exceeding 8 inches and/or a water table within 6 feet of the surface for a period equal to or exceeding 150 days. If neither of these factors apply, the land is designated as *Bench Land*." Lands classified as bottom (or bench) according to USBR criteria, above, will be limited to maximum water deliveries (duty) in accordance to the provision of the *Orr Ditch Decree* and the *Alpine Decree*, which are identical in establishing water duties and establish the following limits: (1) Eligible lands designated as *Bench Lands* may receive a maximum of 4.5 acre-feet per acre per year (AF/acre/year); (2) eligible lands designated as *Bottom Lands* may receive a maximum of 3.5 acre-feet per acre per year (AF/acre/year).

Bottom Material — See *Bed Material*.

Bottom Outlet — An opening at a low level from a reservoir generally used for emptying or for scouring sediment and sometimes for irrigation releases. Also referred to as *Low-Level Outlet* or *Sluiceway*.

Bottom Water — (1) Water that lies immediately below oil or gas deposits within a stratum of rock. (2) (Oceanography) The deepest, densest water mass of a body of sea water.

Boulder — Rock fragments larger than 60.4 cm (24 inches) in diameter.

Boulder Fan — A sloping, fan-shaped mass of boulders deposited by a tributary stream where it enters into the main canyon. These often constrict the river, causing rapids.

Boulder Garden — A rapid densely strewn with boulders that necessitate intricate maneuvering to navigate.

Boundary Conditions — Flow conditions imposed at the ends of a pipeline or canal reach by various physical structures, which must be described mathematically to solve the general equation of flow for hydraulic transient computer models.

Boundary Layer — The layer of reduced velocity in fluids, such as air and water, that is immediately adjacent to the surface of a solid past which the fluid is flowing.

Bound Water — (1) Water molecules that are held tightly to soil or other solids. This water is not easily removed by normal drying and is not available for other purposes such as plant growth. (2) (Wastewater Treatment) Water contained within the cell mass of sludges or strongly held on the surface of colloidal particles. This constitutes one of the causes of bulking sludge in the *Activated Sludge Process*.

Bourn, also Bourne — A stream, brook, or rivulet; in southern England, a winter stream of the chalk downs.

Boussinesq Coefficient — A dimensionless constant that is computed based upon the momentum passing through a section in a channel. Also referred to as *Momentum Coefficient*.

Bowl, Pump — The submerged pumping unit in a well, including the shaft, impellers and housing.

B.P. — Before present.

BPI Pan — A circular evaporation pan, 6 feet in diameter and 2 feet deep, made of unpainted galvanized iron. The pan is buried in the ground so that about 4 inches of the rim extend above the surrounding ground and the water surface is maintained at about ground level. (BPI stands for Bureau of Plant Industry, U.S.D.A., which introduced this instrument.)

Brackish — (1) Term which is applied to water which is intermediate in salinity between that of fresh water streams and sea water; it is slightly salty. (2) Mixed fresh and salt waters. (3) Having a somewhat salty taste, especially from containing a mixture of seawater and fresh water. Also see *Brackish Water*.

Brackish Water — (1) Generally, water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses. Considerably less saline than sea water. (2) Also, *Marine* and *Estuarine* waters with *Mixohaline* salinity (0.5 to 30‰ due to ocean salts). Water containing between 1,000–4,000 parts per million (PPM) *Total Dissolved Solids (TDS)*. The term brackish water is frequently interchangeable with *Saline Water*. The term should not be applied to inland waters.

Braid — To branch and rejoin many times, forming a network of interlacing channels.

Braided Stream — (1) A stream which divides into a network of channels branching and reuniting, separated by islands. (2) A stream that divides into or follows an interlacing or tangled network of several small branching and reuniting shallow channels separated from each other by branch islands or channel bars, resembling in plan the strands of a complex braid. (3) A complex tangle of converging and diverging stream channels (*Anabranches*) separated by sand bars or islands. Characteristic of flood plains where the amount of debris is large in relation to the discharge. Also referred to as an *Anastomosing Stream*.

Braiding (of River Channels) — Successive division and rejoining of riverflow with accompanying islands.

Brake Horsepower — (1) The horsepower required at the top or end of a pump shaft (input to a pump). (2) The energy provided by a motor or other power source.

Branch — (1) A tributary of a river or other body of water. (2) A divergent section of a river, especially near the mouth. (3) Any small stream that flows into or out of another, usually larger, stream. (4) Any small stream, tributary, or distributary.

Branch of the Sea — (Legal) Rivers in which the tide ebbs and flows.

Branch Sewer — A sewer that receives wastewater from a relatively small area and discharges into a main sewer serving more than one branch sewer area.

Branch Water — (Chiefly Southern United States) Plain water from a stream, especially when mixed with a liquor such as whiskey.

Brash — A mass or pile of rubble, refuse, or fragments, as of stone, brush, or ice.

Brash Ice — An accumulation of small floating fragments of ice, resulting from the breakup of larger masses. Also referred to as

Debris Ice.

Brawl — To flow noisily, as turbulent water.

Breach — (1) A gap or rift, especially in or as if in a solid structure such as a dike or dam. (1) The breaking of waves or surf.

Breach Analysis — A simulated dam failure performed to determine the outflow *Hydrograph* and to route the resulting flood wave so as to minimize potential damage and/or loss of life..

Break — (1) To emerge above the surface of the water. (2) (Geology) A marked change in topography such as a fault or deep valley.

Breakaway Walls — Any type of walls, whether solid or lattice, and whether constructed of concrete, masonry, wood, metal, plastic or any other suitable building material which is not part of the structural support of the building and which is designed to break away under abnormally high tides or wave action without causing any damage to the structural integrity of the building on which they are used or any building to which they might be carried by flood waters. A breakaway wall shall have a safe design loading resistance of not less than ten and no more than twenty pounds per square foot. Use of breakaway walls must be certified by a registered engineer or architect and shall meet the following conditions: (1) breakaway wall collapse shall result from a water load less than that which would occur during the base flood, and (2) the elevated portion of the building shall not incur any structural damage due to the effects of wind and water loads acting simultaneously in the event of the base flood.

Breaker — A small water cask.

Breakout of Chlorine — A point at which chlorine leaves solution as a gas because the chlorine feed rate is too high. The solution is saturated and cannot dissolve any more chlorine. The maximum strength a chlorine solution can attain is approximately 3,500 mg/L.

Breakpoint Chlorination — (Wastewater Treatment) The addition of chlorine to water or wastewater until the chlorine demand has been satisfied. At this point, further additions of chlorine will result in a free residual chlorine that is directly proportional to the amount of chlorine added beyond the breakpoint.

Breakthrough — A crack or break in a filter bed allowing the passage of floc or particulate matter through a filter. This will cause an increase in filter effluent turbidity. A breakthrough can occur: (1) when a filter is first placed in service; (2) when the effluent valve suddenly opens or closes; and (3) during periods of excessive head loss through the filter (including when the filter is exposed to negative heads).

Breakthrough Curve — A plot of relative concentration versus time, where relative concentration is defined as C/C_0 ; the concentration at a point in the ground-water flow domain divided by the source concentration.

Breakup — (1) The cracking and shifting of ice in rivers or harbors during the spring. The melting, loosening, or destruction of winter snow or ice that occurs during springtime. (2) The period when such a thaw occurs.

Breakwater — A barrier that protects a harbor or shore from the full impact of waves.

Breathing — A term for the rising and falling of the water level of a river. See *River Breathing*.

Breccia — (Geology) A general term for a rock made up of coarse angular fragments as distinguished from conglomerate which is composed of rounded rock fragments. There are sedimentary as well as volcanic and other types of breccia.

Brew — To prepare (as tea) by infusion in hot water.

Bridal Veil Falls — A waterfall of great height and relatively low water volume, such that the falling water is largely dissipated in a fine, misty spray, resembling a white veil, before it reaches the base of the falls. Bridal Veil Falls in Yosemite Valley, California represents one of the most noted example of this type of falls.

Bridge — An obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by filter pack materials during well completion. Bridging can also occur in the formation during well development.

Brim — The upper surface of a body of water.

Brine — (1) A general term for sea water. (2) Water which is saturated or nearly saturated with salt. Sea water that is unusually high in salt content because of evaporation or freezing. (3) Water saturated with or containing large amounts of a salt, especially of sodium chloride. According to *U.S. Geologic Survey (USGS)* classification, water classified as brine contains more than 35,000 ppm (parts per million) total dissolved solids (TDS) of salt. (4) The water of a sea or an ocean. (5) A large body of salt water. (6) The wastewater resulting from desalting. It is higher in dissolved solid content than feedwater or product water. Also see *Saline Water*.

Brine Cell — A small enclosure in sea ice, containing residual liquid that is higher in salt content than ordinary seawater. Also referred to as a *Brine Pocket*.

Brine Disposal — Removing water that contains high concentrations of salt.

Brine Lake — See *Salt Lake*.

Brine Mud — Waste material, often associated with well-drilling or mining, composed of mineral salts or other inorganic compounds.

Brine Pit — An opening at the mouth of a salt spring, from which water is obtained to be evaporated for salt.

Brine Pocket — See *Brine Cell*.

Brinelling — Tiny indentations (dents) high on the shoulder of the bearing race or bearing. A type of bearing failure.

Brink — (1) The upper edge of a steep or vertical slope. (2) The margin of land bordering a body of water.

British Thermal Unit (BTU) — A unit of heat energy equal to the amount of heat required to raise the temperature of one pound of water one degree *Fahrenheit*. More precisely, the quantity of heat required to raise the temperature of one pound of water from 60EF to 61EF at a constant pressure of one atmosphere. Also, the quantity of heat equal to 1/180 of the heat required to raise the temperature of one pound of water from 32EF (its freezing point) to 212EF (its boiling point) at a constant pressure of one atmosphere. The British Thermal Unit is used when the measurement is in degrees *Fahrenheit* (EF) on the *Fahrenheit Scale* and the *Calorie* is used when temperature is measured in degrees *Celsius* (EC) on the *Centigrade Temperature Scale*.

Broad-Leaved Deciduous — Woody *Angiosperms* (trees or shrubs) with relatively wide, flat leaves that are shed during the cold or dry season; e.g., black ash (*Fraxinus nigra*).

Broad-Leaved Evergreen — Woody *Angiosperms* (trees or shrubs) with relatively wide, flat leaves that generally remain green and are usually persistent for a year or more; e.g., red mangrove (*Rhizophora mangle*).

Broadcast Spawners — Fish that release their eggs and milt in the water column.

Broken Belt — A band of broken ice that forms a transition between solid ice and open water.

Broken Stream — A stream that disappears and reappears over and over again from underground flow to surface flow, as in an arid region.

Bromide — A salt which naturally occurs in small quantities in sea water; a compound of bromine.

Brook — (1) A natural stream of flowing water, regarded as smaller than a creek, especially a stream that flows swiftly over a rocky bed. (2) A natural stream of water, smaller than a river or creek; especially a small stream or rivulet which breaks directly out of the ground, as from a spring or seep; also, a stream or torrent of similar size, produced by copious rainfall, melting snow and ice, etc. (3) A primary stream not formed by tributaries, though often fed below its source, as by rills or runlets; one of the smallest branches or ultimate ramifications of a drainage system.

Brown Marsh — (Ecology) Also referred to as marsh or wetland “dieback,” brown marsh represents the dramatic change in color of a wetland area when major areas of the flora die. This has been a particularly severe problem most recently in the salt marshes of Coastal Louisiana. In that extensive wetland area, smooth cordgrass (*Spartina alterniflora*), or oyster grass, is the most abundant plant. Therefore, any factors that affect these plants have the capacity for wide area impact. The precise cause of the current large area browning is not yet fully understood, but there are working hypotheses that are being evaluated. Under normal circumstances smooth cordgrass is highly resistant to saltwater. One theory purports that climatic factors, especially the current prolonged drought, has interacted to stress these plants beyond their ability to recover. Even if climatic factors do not kill the cordgrass directly, the stress may be sufficient to render the plants more susceptible to naturally occurring pathogens.

Brown Tides — Brown (and red) tides can occur when certain algae species reach high concentrations, or “blooms,” that discolor water. Some of these algae species can harm some marine life under certain conditions. Scientists call such events “harmful algal blooms.” Not all algal blooms that discolor the water are harmful to the environment. The organism that have caused brown tides on the east coast of the United States, *Aureococcus anophagefferens*, was first discovered in 1985. There are no known human health impacts from brown tides. Also, they also do not appear to harm fish - fish simply avoid bloom areas. Brown tide blooms with high densities greater than 500,000 cells per milliliter (ml) may have severe impacts on bay and estuary life that cannot move away from the blooms. For example, *Aureococcus* blooms frequently coincide with the spawning season of several commercially important bivalves – i.e., clams, oysters, scallops – in mid-Atlantic estuaries, thus threatening their reproductive success and population growth.

Brownian Movement — The constant, random, zigzag movement of small particles dispersed in a fluid medium, caused by collision with molecules of the fluid. Named after Robert Brown (1773–1858), the British botanist who first described it. Also referred to as *Brownian Motion*.

Browsing — The consumption by livestock and wildlife of leaves and shoots from woody plants. See *Grazing*.

Bubble — (1) A thin, usually spherical or hemispherical film of liquid filled with air or gas, as a soap bubble. (2) A globular body of air or gas formed within a liquid, as air bubbles rising to the surface of a body of water.

Bubbler — A drinking fountain from which a stream of water bubbles upward.

Buchner Funnel — (Wastewater Treatment) A special funnel used to separate solids (sludge) from a mixture. A perforated plate or a filter paper is placed in the lower portion of the funnel to hold the mixture (wet sludge). The funnel is placed in a filter flask and a vacuum is applied to remove the liquid (dewater the sludge).

Bucket — (1) A cylindrical vessel used for holding or carrying water or other liquids; a pail. (2) A receptacle on various machines, such as the compartments on a water wheel, used to gather and convey water.

Buddle — An inclined trough in which crushed ore is washed with running water to flush away impurities.

Buffer — (1) A solution or liquid whose chemical makeup neutralizes acids or bases without a great change in pH. (2) A solution which is resistant to pH changes, or a solution or liquid whose chemical makeup tends to neutralize acids or bases without a great change in pH. Surface waters and soils with chemical buffers are not as susceptible to acid deposition as those with poor buffering capacity.

Buffer Capacity — A measure of the capacity of a solution or liquid to neutralize acids or bases. This is a measure of the capacity of water for offering a resistance to changes in pH.

Buffer Strips — (1) Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields. (2) Grassed or planted zones which act as a protective barrier between an area which experiences livestock grazing or other activities and a water body. (3) Strips of grass or other close-growing vegetation that separate a waterway (ditch, stream, creek) from an intensive land use area (subdivision, farm); also referred to as filter strips, vegetated filter strips, and grassed buffers. Also referred to as a *Buffer Zone* and *Buffers*.

Buffer Zone — (1) A protective, neutral area between distinct environments. (2) An area which acts to minimize the impact of pollutants on the environment or public welfare. For example, a buffer zone may be established between a composting facility and nearby neighborhoods to minimize odor problems. Also see *Buffer Strips* and *Buffers*.

Buffers — Land adjoining and immediately adjacent to a river or stream that provides protection from or filters unwanted constituents.

Building Sewer — A gravity flow pipeline connecting a building wastewater collection system to a lateral or branch sewer. The building sewer may begin at the outside of the building” foundation wall or some distance (such as 2 to 10 feet) from the wall, depending on local sewer ordinances. Also called a “house connection” or a “service connection.”

Building Wastewater Collection System — All of the wastewater drain pipes and their hardware that connect plumbing fixtures inside or adjacent to a building to the building sewers. This includes traps, vents and cleanouts.

Built Terrace — See *Alluvial Terrace*.

Bulkhead — A low wall of stones, concrete, or piling built to protect a shore, or fills, from wave erosion.

Bulking — (Wastewater Treatment) Clouds of billowing sludge that occur throughout secondary clarifiers and sludge thickeners when the sludge does not settle properly. In the activated sludge process, bulking is usually caused by filamentous bacteria or bound water.

Bulking Sludge — (Wastewater Treatment) Sludge that does not settle to the bottom of a clarifier, causing a rise in the level of suspended solids and biochemical oxygen demand in water leaving a wastewater treatment facility.

Bund — An embankment used especially in India to control the flow of water.

Buoy — (Nautical) A float, often having a bell or light, moored in water as a warning of danger or as a marker for a channel. Also, to keep afloat or aloft.

Buoyancy — The tendency of a body to float or rise when submerged in a fluid.

Buran — A violent windstorm of the Eurasian steppes, accompanied in summer by dust and in winter by snow.

Burble — (1) A gurgling or bubbling sound, as of running water. (2) A separation in the *Boundary Layer* of a fluid about a moving streamlined body, such as the wing of an airplane through air or the keel of a sailboat through water, causing a breakdown in the smooth flow of fluid and resulting in turbulence.

(United States) Bureau of Indian Affairs (BIA) [USDI] — An agency of the U.S. Department of the Interior (USDI) which has the primary responsibility for exercising the federal government's trust relationship with Indian tribes. The BIA was first established in 1824 in the War Department, then transferred to the Department of the Interior in 1849. The BIA has prime responsibility to provide services to Indian tribes and plays a central role in the settlement process of Indian water rights disputes. The BIA exercises prime trust responsibility in providing federal government protection for Indian resources and federal assistance in resource development and management. Quite often this responsibility complicates the Department of the Interior's other broad responsibilities to manage the use of lands and natural resources on public lands through its *Bureau of Land Management (BLM)* land use programs, its *Bureau of Reclamation (USBR)* water-related projects, and its *U.S. Fish and Wildlife Service (USFWS)* wildlife and habitat restoration programs, which may frequently come in conflict with the Bureau of Indian Affairs Indian water rights issues. [For example, in *Nevada v. United States* (463 U.S. 129{1983}), the United States Supreme Court held that the United States (Department of the Interior) could adequately represent more than one interest simultaneously, and so it is not subject to the same standards as a private trustee. In this case, the Court found that claims made by the United States on behalf of the Pyramid Lake Paiute Indian Tribe to protect fisheries should have been asserted in prior litigation. Nevertheless, the Court found the failure to do so was not a breach of its trust obligations to the tribe, even though the United States also had protected the competing interests of non-Indian irrigators.] Also see *Negotiated Settlement* and *Truckee River Operating Agreement (TROA)*.

(United States) Bureau of Land Management (BLM) [USDI] — An agency of the U.S. Department of the Interior (USDI) responsible for the stewardship of the nation's public lands. The Bureau of Land Management is committed to the sustained management, protection, and improvement of these lands in a manner consistent with the needs of the American people. The BLM's management philosophy is based on the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. The resources under the BLM's oversight include recreation, rangelands, timber, minerals, watersheds, fish and wildlife, wilderness, air, and scenic, scientific and cultural values. The BLM oversees the largest natural resource base in the federal government. This base includes 270 million acres of public lands ranging from old growth forests in the Pacific Northwest to sun drenched desert ecosystems in the Southwest to Arctic tundra in Alaska. The BLM also supervises mineral leasing and operations on an additional 300 million acres of federal mineral estate that underlie other surface ownerships. BLM managed public lands provide habitat for thousands of wildlife and plant species, including some 220 federally-listed threatened and endangered species and 1,200 species considered candidates for listing. The BLM manages over 169,000 miles of fish bearing streams and more than 50 million acres of forested lands. In addition, the BLM is caretaker of an estimated 4 million cultural properties, including 400 listed in the *National Register of Historic Places*. The BLM also manages more than 1.6 million acres of designated wilderness and 22.8 million acres of wilderness study areas. More than 46,500 wild horses and burros roam BLM land in the West. The BLM permits and manages various uses of the public lands, including grazing, mining, recreation, and timber operations. These activities traditionally have been managed on an individual basis. However, more recently the BLM's management efforts have shifted to a more comprehensive ecosystem basis of managing such lands to insure sustained benefits for future generations of Americans. The Bureau of Land Management has its headquarters office in Washington, D.C. There are an additional eleven state offices for managing resources in the western states of Alaska, Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Wyoming. BLM resources for the Eastern United States are managed out of Springfield, Virginia. The BLM also supports a National Interagency Fire Center (NIFC) in Boise, Idaho as well as a public information service center (SC) in Denver, Colorado and a centralized employee training center in Phoenix, Arizona. In Nevada alone, the BLM manages some 48 million acres of public lands or approximately 67 percent of all lands in Nevada.

(United States) Bureau of Reclamation (BOR or USBR) [USDI] — An agency of the U.S. Department of the Interior [USDI] responsible for many of the dam, reservoir, and irrigation projects in the Western United States. The USBR reclamation program was authorized by the Reclamation Act of 1902 which was initially intended to reclaim the arid and semiarid lands of the Western United States by conserving and supplying irrigation water to make them productive. Since that beginning, the USBR's mission has expanded considerably to include multipurpose water development by providing water for irrigation, hydroelectric power, water for homes, businesses and factories, outdoor recreation, flood control, fish and wildlife enhancement, improved water

quality, river regulation and control, and other related uses of water. Currently the USBR administers some 322 storage dams, 14,490 miles of canals, 174 pumping plants, and 50 hydroelectric plants. USBR water irrigates 146,000 farms in the West, provides part or all the water needs on nearly 10 million acres, yielding enough food for 33 million people, and also provides 620 billion gallons of water a year of municipal and industrial use in western towns and cities. In terms of its original intent and broad governing guidelines, the U.S. Bureau of Reclamation is primarily responsible for water projects with respect to developing water sources for agriculture and commerce, while the *U.S. Army Corps of Engineers (COE)* has had primary responsibility for water projects which protect property from potential flood damage. In reality, however, quite often these federal agencies' project goals overlap with USBR's dams and reservoirs providing important flood protection and the COE's water projects – dams, locks, and canals – providing important water transportation linkages and benefits to commerce.

Buried Drain — A covered drain usually made of clay, concrete, or plastic pipe installed beneath the ground surface at a planned grade and depth for conveyance of excess groundwater.

Buried Valley — A depression in an ancient land surface or in bedrock now covered by younger deposits, especially a preglacial valley filled with glacial drift.

Burn — (Chiefly Scottish) (1) A brook; a rivulet. (2) Water, especially that used in brewing.

Bushel — (1) A unit of volume or capacity in the U.S. Customary System, used in dry measure and equal to 4 pecks, 2,150.42 cubic inches, or 35.24 liters. (2) A unit of volume or capacity in the British Imperial System, used in dry and liquid measure and equal to 2,219.36 cubic inches or 36.37 liters.

Butt — A large cask especially for wine, beer, or water.

Butt End — The bottom end of a cutting taken from a riparian plant that will root if planted in soil (it is opposite the budding tip's end of the cutting).

Buttress Dam — A dam consisting of a watertight upstream face supported at intervals on the downstream side by a series of buttresses. Also see *Dam*.

Bypass, also By-Pass — (1) A pipe or channel used to conduct a liquid around another pipe or a fixture. (2) (Wastewater Treatment) A pipe, valve, gate, weir, trench or other device designed to permit all or part of a wastewater flow to be diverted from usual channels or flow. Sometimes refers to a special line which carries the flow around a facility or device that needs maintenance or repair.

Bypass System — A structure in a dam that provides a route for fish to move through or around the dam without going through the turbines.

Bypassed — The situation of a fan or pediment surface that once had sediment spread across it by ephemeral washes, but that is now protected from surficial stream erosion or alluviation because the drainageways crossing it are now incised.

Bypassing — (Wastewater Treatment) The act of causing all or part of a flow to be diverted from its usual channels. In a wastewater treatment plant, overload flows should be bypassed into a holding pond for future treatment.

C

C Factor — A factor of value used to indicate the smoothness of the interior of a pipe. The higher the C Factor, the smoother the pipe, the greater the carrying capacity, and the smaller the friction or energy losses from water flowing in the pipe. To calculate the C Factor, measure the flow, pipe diameter, distance between two pressure gages, and the friction or energy loss of the water between the gages.

C-Horizon — A layer of unconsolidated material, relatively little affected by the influence of organisms and presumed to be similar in chemical, physical, and mineralogical composition to the material from which at least a portion of the overlying *Solum* has developed.

Cabotage — (1) (From the Spanish) A nautical term denoting navigation from cape to cape along the coast without having to go out into the open sea. (2) (International Law) Navigating and trading along the coast and between coastal ports; trade or transport in coastal waters or airspace or between two points within a country.

CAC — See *Combined Available Chlorine*.

Caisson — (1) A watertight structure within which construction work is carried on under water. A structure or chamber which is usually sunk or lowered by digging from the inside. Used to gain access to the bottom of a stream or other body of water. (2) A large box open at the top and one side, designed to fit against the side of a ship and used to repair damaged hulls under water. (3) A floating structure used to close off the entrance to a dock or canal lock. Also referred to as a *Camel*.

Cake — See *Ice Cake*.

Calcareous — (1) Containing calcium carbonate, CaCO_3 . (2) Formed of calcium carbonate or magnesium carbonate by biological deposition or inorganic precipitation in sufficient quantities to effervesce carbon dioxide visibly when treated with cold 0.1 normal hydrochloric acid. Calcareous sands are usually formed of a mixture of fragments of mollusk shell, echinoderm spines and skeletal material, coral, foraminifera, and algal platelets.

Calcareous Fens — *Peatlands* formed in areas of groundwater discharge, where cold, anoxic, mineral-rich water provides a specialized habitat for disproportionately large numbers of rare and endangered plants. Many of the plants found in calcareous fens are species which would be typical of more northern habitats. The health of such fens is inextricably linked to the presence of the upwelling groundwater. Also see *Peat (Peatlands)*.

Calcic Horizon — A secondary *Calcium Carbonate* accumulation in the lower *B-Horizon* that occurs as coatings on *Clasts* and as lenses in fine-grained sediment matrices; it is at least 15 centimeters (5.9 inches) thick and contains 15 percent or more calcium carbonate.

Calcine — Heated to temperature of dissociation; for example, heat gypsum to the temperature where the water of crystallization is driven off.

Calcite — (Geology) Calcium carbonate (CaCO_3), with hexagonal crystallization, a mineral found in the form of limestone, chalk, and marble.

Calcium Carbonate — Chemical symbol: CaCO_3 . The principal hardness and scale-causing compound in water. A white precipitate that forms in water lines, water heaters, and boilers in hard water areas; also known as scale. Also the principal chemical composition of *Tufa*, a calcareous and siliceous rock deposit of springs, lakes, or groundwater.

Calcium Carbonate Equilibrium — A water is considered stable when it is just saturated with calcium carbonate. In this condition the water will neither dissolve nor deposit calcium carbonate. Thus, in this water the calcium carbonate is in equilibrium with the hydrogen ion concentration.

Calcium Carbonate (CaCO_3) Equivalent — An expression of the concentration of specified constituents in water in terms of their equivalent value to calcium carbonate. For example, the hardness in water which is caused by calcium, magnesium and other ions is usually described as calcium carbonate equivalent. Alkalinity test results are usually reported as mg/L CaCO_3 equivalents. To convert chloride to CaCO_3 equivalents, multiply the concentration of chloride ions in mg/L by 1.41, and for sulfate, multiply by 1.04.

Calcium Chloride — A white deliquescent compound, CaCl_2 , used chiefly as a drying agent, refrigerant, and preservative and for controlling dust and ice on roads.

Calcium Hydroxide — A white crystalline strong alkali $\text{Ca}(\text{OH})_2$ that is used especially to make mortar and plaster and to soften water.

Caldera — A large crater formed by a volcanic explosion or by the collapse of a volcanic cone. Frequently, such formations fill with water forming a *Crater Lake*. See, for example, *Crater Lake [Oregon]*.

Calf — A large floating chunk of ice split off from a glacier, an iceberg, or a floe.

CALFED [California] — A group of California (CAL) and federal (FED) agencies that have joined together to insure the long-term survival of the *Sacramento-San Joaquin Delta*. In 1996 a coalition of federal and state agencies with management and regulatory responsibilities in the Bay-Delta developed a list of proposals to restore the Delta ecosystem and alleviate chronic water management problems dealing primarily with issues relating to water transfer and water quality. This consortium, known as CALFED, is advised by the Bay-Delta Advisory Council (BDAC) as it develops a long-term solution for the Bay-Delta region.

BDAC members are appointed by the Governor of the State of California and the Secretary of the Interior and represent the agricultural, urban, environmental, fishing, and business communities. Also see *Central Valley [California]*, *Central Valley Project (CVP)*, and *Central Valley Project Improvement Act (CVPIA)*.

Calgon — Trademark product used for a water softener.

Calibration — A procedure which checks or adjusts an instrument's accuracy by comparison with a standard or reference.

Caliche — (1) A soil layer near the surface, more or less cemented by secondary carbonates of calcium or magnesium precipitated from the soil solution. It may occur as a soft, thin soil horizon, as a hard, thick bed just beneath the *Solum*, or as a surface layer exposed by erosion. (2) *Alluvium* cemented with sodium nitrate, chloride, and/or other soluble salts in the nitrate deposits of Chile and Peru. Also referred to as *Hardpan*.

California Doctrine — A system of allocating water, first announced in California, which combines *Riparian Rights* and *Appropriative Rights*. A number of states have applied this doctrine at one time or another. However, most states have essentially abandoned the doctrine in favor of the *Appropriation Doctrine*, and it is primarily of historical significance. Also see *Alpine Decree [California and Nevada]*.

California Environmental Quality Act (CEQA) — The California equivalent of the federal *National Environmental Policy Act (NEPA)*.

California Environmental Resources Evaluation System (CERES) — CERES is an information system developed by the *California Resources Agency* to facilitate access to a variety of electronic data describing California's rich and diverse environments. The goal of CERES is to improve environmental analysis and planning by integrating natural and cultural resource information from multiple contributors and by making it available and useful to a wide variety of users. CERES collects and integrates data and information and distributes it via the World Wide Web (www), tapping into important information sources and contributing to advances in the science of data management and metadata cataloging (data about the data) by encouraging cooperation among governmental, educational, and private groups. CERES focuses on three related components: (1) technology; (2) data; and (3) community. The first, *technology*, includes the development of new software and network structures to accommodate the search and retrieval, organization, and accessibility demands associated with huge volumes of data in a wide range of forms. The second, *data*, encompasses the conversion of vast quantities of information into digital form as well as the evaluation of existing digital data sets and the development of metadata catalogs required searching and data-quality and appropriate use assessment. The third, *community*, contains CERES' efforts to promote the use of the network for planning and policy and to foster the growth of new users and contributors in a far-reaching web of affiliations. CERES also coordinates focused applications to support well-defined natural resource management activities and to supply the public with critical and timely information.

California Irrigation Management Information System (CIMIS) — A computerized system to improve water use efficiency in agriculture that provides data farmers can use to gauge the amount of water their crops need on a daily basis. The CIMIS uses more than 85 automated stations across the state to gather weather data used to provide location-specific information on plant water usage (i.e., *Evapotranspiration*). Changes in evapotranspiration rates can be correlated by growers with published crop coefficients to yield estimates of optimal water needs of specific crops for specific geographic areas.

California Method — A type of frequency analysis that uses as a parameter the average time between the occurrence of a hydrological quantity and that of an equal or greater quantity.

California–Nevada Interstate Compact [California and Nevada] — After thirteen years of negotiations between the two states (begun in 1955), the joint California–Nevada Interstate Compact Commission approved a provisional Interstate Compact in July 1968 for the division of the waters of Lake Tahoe, and the Truckee, Carson, and Walker rivers. This provisional compact, with some modification, was eventually ratified by both states (California in September 1970 and Nevada in March 1971). The compact created the Tahoe Regional Planning Agency (TRPA) to oversee land-use planning and environmental issues within the Lake Tahoe Basin. However, the compact was never ratified by Congress which would have made it law. A major issue of contention was a phrase in the compact which stated that the use of waters by the federal government, its agencies, instrumentalities, or wards was to be against the use by the state in which it is made. This limitation, combined with new court interpretations of the federal *reserved water rights (Winters Doctrine)*, waters required for Pyramid Lake fish species under the *Endangered Species Act (ESA)*, and *public trust doctrine* issues combined to derail Congressional approval. Even so, both states chose to implement its terms under individual state legislation. With respect to the Lake Tahoe Basin, the compact provided for a maximum annual gross diversion from all sources of 34,000 acre-feet, of which California was allocated 23,000 acre-feet per year and Nevada 11,000 acre-feet per year.

California Resources Agency — See *(The) Resources Agency [California]*.

California Rivers Assessment (CARA) — The California Rivers Assessment is a computer-based data management system designed to give resource managers, policy-makers, landowners, scientists and interested citizens rapid access to essential information and tools with which to make sound decisions about the conservation and use of California's rivers. To date, throughout the United States, rivers assessments have been conducted or are underway in 20 states. Each state had a unique purpose for undertaking its assessment – to analyze the suitability of a river for hydroelectric power, to determine eligibility for a state wild and scenic rivers program, or to establish priorities for land acquisition and management – and each state required an approach specifically tailored to its resources, issues and institutions. CARA is a cooperative project initiated by the *California Resources Agency* and its partners to provide timely access to information that can improve our knowledge about river resources in a statewide context. The following points are key to using and understanding CARA:

- California Senate Bill 1086 (Sacramento River Riparian Habitat Program);
- The Internet provides primary access to CARA (<http://www.ice.ucdavis.edu/newcara>);
- CARA uses a *Geographic Information System (GIS)* that gives each piece of data a unique address within the state's river and watershed system;

- CARA is both a database and a link to other environmental data sources;
- Many of CARA's GIS layers are based upon proprietary data sets. Maps made from these layers may be freely distributed by CARA, but the underlying data sets used to create the maps must be acquired directly from the source provider. While some data are available free of charge, many providers charge for access to their holdings; and
- CARA is an ongoing project. Data, as well as improved access and analysis technologies will be added as funding becomes available.

California Species of Special Concern — Species which are not federal or state-listed as endangered, threatened, or rare, but are declining or are so few in number in California that extirpation is a possibility.

California State Water Resources Control Board (SWRCB) — See *State Water Resources Control Board (SWRCB) [California]*.

California Water Commission — See *Department of Water Resources (DWR) [California]*.

Call the River — To make a request or demand that water rights holders on a watercourse appropriate water only in accordance with the ranking of their *Priority Date*.

Calm — A period or condition of freedom from storms, high winds, or rough activity of water.

Calorie — (Abbreviation cal) (1) Basically, A unit of heat energy equal to the amount of heat needed to raise the temperature of one gram of water one degree *Celsius* (EC). More precisely, any of several approximately equal units of heat, each measured as the quantity of heat required to raise the temperature of 1 gram of water by 1EC from a standard initial temperature, especially from 3.98EC (corresponding to the maximum density of water), 14.5EC, or 19.5EC, at 1 atmosphere pressure. Also referred to as the *Gram Calorie* and the *Small Calorie*. (2) The unit of heat equal to 1/100 the quantity of heat required to raise the temperature of 1 gram of water from 0EC (its freezing point) to 100EC (its boiling point) at 1 atmosphere pressure. Also referred to as the *Mean Calorie*. (3) The unit of heat equal to the amount of heat required to raise the temperature of 1 kilogram of water by 1EC at 1 atmosphere pressure. Also referred to as the *Kilocalorie*, *Kilogram Calorie*, and *Large Calorie*. (4) A unit of energy-producing potential equal to this amount of heat that is contained in food and released upon oxidation by the body. Also referred to as the *Nutritionist's Calorie*. The calorie is used when temperature is measured in degrees *Celsius* (EC) on the *Centigrade Temperature Scale*. The *British Thermal Unit (BTU)* is used when the measurement is in degrees *Fahrenheit* (EF) on the *Fahrenheit Scale*.

Calve — To break at an edge, so that a portion separates. Used of a glacier or an iceberg. Also see *Calving*.

Calved Ice — (Oceanography) A fragment of floating ice that has separated from a coast glacier or an iceberg.

Calving — (1) The breaking away of a mass of ice from a glacier, an ice shelf, or an iceberg. (2) (Geology) The falling or caving in of a mass of earth or rock.

Camel — A device used to raise sunken objects, consisting of a hollow structure that is submerged, attached tightly to the object, and pumped free of water. Also referred to as a *Caisson*.

Canal — A constructed open channel for transporting water from the source of supply to the point of distribution.

Canal Automation — The implementation of a control system that upgrades the conventional method of canal system operation.

Canal Check Gate Structure — A structure designed to control the water surface level and flow in a canal, maintaining a specified water depth or head on outlets or turnout structures. Most canal check structures have movable gates.

Canal Freeboard — The amount of canal lining available above maximum design water depth.

Canal Losses — Seepage, evaporation, and operation spills from main-line canals and regulatory reservoirs.

Canal Pool — Canal section between check structures.

Canal Prism — The cross-sectional shape of a typical canal.

Canal Reach — The segment of the main canal system consisting of a series of canal pools between major flow control structures.

Canal System Operation — Water transfer from its source to points of diversion for irrigation, municipal and industrial, fish and wildlife, and drainage purposes.

Cancel — Termination of the right to make a beneficial use of water resulting from abandonment or forfeiture of the beneficial use.

Canceled Water Right — A water right that is invalidated due to the failure of the water right holder to comply with the terms and conditions of the permit. Also see *Forfeited Water Right* and *Withdrawn Water Right*.

Candidate Species — Plant or animal species designated by the Department of the Interior, *U.S. Fish and Wildlife Service (USFWS)* as candidates for potential future listing as an *Endangered Species* or *Threatened Species* pursuant to the *Endangered Species Act (ESA)* of 1973; plant or animal species that are candidates for designation as endangered (in danger of becoming extinct) or threatened (likely to become endangered).

Canopy — (1) The overhanging cover formed by leaves, needles, and branches of vegetation. (2) The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and shrubs.

Canopy Resistance — The resistance to transport of water and vapor away from the soil and canopy.

Canyon, also Cañon — A narrow chasm with steep cliff walls, cut into the earth by running water; a gorge.

Cap — A layer of clay, or other impermeable material installed over the top of a closed landfill to prevent entry of rainwater and minimize *Leachate*.

CAPA — See *Critical Aquifer Protection Area*.

Capacitive Deionization (CDI) — A relatively simple and straight forward electrochemical reaction process made unique and highly efficient through the development of a highly-porous material called carbon aerogel that absorbs huge volumes of ions. A single cube of carbon aerogel, one inch on a side, has an effective surface area of more than 20 million square inches. This unusually high surface area makes it possible to adsorb large numbers of ions. Water containing salt, heavy metals, or even radioactive isotopes is pumped through a series of electrochemical cells made from the aerogel, a material sometimes called "frozen smoke." Effluent water from the series of stacked cells is subsequently purified. The trapped ions can be released into a relatively small stream of "rinse" water typically comprising less than one percent of the total volume of produce water. Also see *Deionization*.

Capacity — The ability of water or wind to transport material, as measured by the quantity that can be carried at any given time.

- Capacity, Field or Soil** — The amount of water held in a soil sample after the excess gravitation water has drained away.
- Capacity, Gross Reservoir** — The total amount of storage capacity available in a reservoir for all purposes from the streambed to the normal maximum operating level. It does not include surcharge, but does include dead storage.
- Cape** — A point or head of land projecting into a body of water.
- Capillarity** — (1) The property of tubes or earth-like particles with hairlike openings which, when immersed in fluid, raise (or depress) the fluid in the tubes above (or below) the surface of the fluid in which they are immersed. (2) The interaction between contacting surfaces of a liquid and a solid that distorts the liquid surface from a planar shape. Also referred to as *Capillary Action* or *Capillary Attraction*.
- Capillary Action** — (1) The movement of water through very small spaces due to molecular forces. The action by which water is drawn around soil particles because there is a stronger attraction between the soil particles and the water molecules themselves. (2) The movement of water within the interstices of a porous medium due to the forces of adhesion, cohesion, and surface tension acting in a liquid that is in contact with a solid. Synonymous with the terms *Capillarity*, *Capillary Flow*, and *Capillary Migration*.
- Capillary Attraction** — The force that results from greater adhesion of a liquid to a solid surface than internal cohesion of the liquid itself and that causes the liquid to be raised against a vertical surface, as water is in a clean glass tube. It is the force that allows a porous material like soil to soak up water from lower levels.
- Capillary Flow** — See *Capillary Migration*.
- Capillary Forces** — The molecular forces which cause the movement of water through very small spaces.
- Capillary Fringe** — (1) The porous material just above the water table which may hold water by capillarity (a property of surface tension that draws water upwards) in the smaller void spaces. (2) The zone at the bottom of the *Zone of Aeration (Vadose Zone)* where groundwater is drawn upward by capillary force. (3) The zone immediately above the *Zone of Saturation* (or *Groundwater Table*) in which underground water is lifted against gravity by surface tension (*Capillary Action*) in passages of capillary size. (4) The lower subdivision of the zone of aeration, located just above the *Water Table* and containing water under less than standard atmospheric pressure. Also referred to as the *Capillary-Moisture Zone*.
- Capillary Interstice** — A pore space that is small enough to hold water at a height above a free water surface by surface tension, but large enough to prevent molecular attraction from extending across the opening.
- Capillary Migration** — The movement of water into small spaces in rock or soil as a result of surface tension. Also referred to as *Capillary Flow*.
- Capillary-Moisture Zone** — See *Capillary Fringe*.
- Capillary Phenomena** — A phenomenon of water movement caused by *Capillarity*.
- Capillary Potential** — The work required to move a unit mass of water from the reference plane to any point in the soil column.
- Capillary Rise** — The height above a free water surface to which water will rise by *Capillary Action*.
- Capillary Water** — (1) Water that is held in or moving through small spaces between soil particles as a result of surface tension. (2) The water which is held in the soil above the *Water Table* or upper surface of the *Zone of Saturation* by capillary action. It includes the water content of the soil beyond its hygroscopic moisture content, which is held against the force of gravity by surface tension. (3) Water held in the soil above the *Phreatic Surface* by capillary forces; or soil water above hygroscopic moisture and below the field capacity. (4) A continuous film of water found around soil particles. (5) Water in the *Capillary Fringe*.
- Capillary Zone** — The soil area above the water table where water can rise up slightly through the cohesive force of *Capillary Action*.
- Capital Costs** — The costs (usually requiring long-term debt) of financing construction and equipment, say for a water or wastewater treatment plant. Capital costs are usually fixed, one-time expenses which are independent of the amount of water produced.
- Capped Column** — A hexagonal-shaped, columnar crystal of ice or snow having thin plates or stars at each end.
- Caprock** — Usually has reference to an impermeable rock layer which immediately overlies an aquifer or an oil or gas-bearing rock.
- Capturability** — A term used to indicate the accessibility of the water in an aquifer based on ease of extraction and associated well construction requirements and costs. Also see *Capture*.
- Capture** — (1) Water withdrawn artificially from an aquifer is derived from a decrease in storage in the aquifer, a reduction in the previous discharge from the aquifer, an increase in the recharge, or a combination of these changes. The decrease in discharge from an aquifer plus the increase in recharge. Capture may occur in the form of decreases in the ground-water discharge into streams, lakes, and the ocean, or from decreases in that component of *Evapotranspiration* derived from the *Zone of Saturation*. (2) Diversion of the flow of water in the upper part of a stream by the headward growth of another stream.
- Capture Zone** — The zone around a well contributing water to the well; the area on the ground surface from which a well captures water.
- CARA** — See *California Rivers Assessment*.
- Carbamates** — A class of new-age pesticides that attack the nervous system of organisms.
- Carbon Adsorption** — (Water Quality) A treatment system that removes contaminants from groundwater or surface water by forcing it through tanks containing activated carbon treated to attract the contaminants.
- Carbon-Chloroform Extract (CCE)** — A measurement of the organic content of a water. It consists of adsorbing the organic matter onto activated carbon, then extracting it with chloroform.
- Carbon Filtration** — (Water Quality) The passage of treated wastewater or domestic water supplies through activated charcoal in an effort to remove low concentrations of dissolved chemicals.
- Carbon Dioxide** — A colorless, odorless, nonpoisonous gas, CO₂, present in the atmosphere and formed during respiration that forms *Carbonic Acid* when dissolved in water. Oil refineries contribute to the problem of this gas in the air. Carbon dioxide is typically

produced during combustion and microbial decomposition. Because carbon dioxide absorbs infrared radiation, rising levels of carbon dioxide in the global atmosphere over the past century have prompted concerns about climatic change and more specifically the *Greenhouse Effect*.

Carbon Monoxide — A colorless, odorless, poisonous gas discharged in automobile exhausts; also, by planes, industrial plants, furnaces and incinerators. Results from incomplete combustion.

Carbon Polishing — (Water Quality) The removal of residual dissolved organic substances from wastewater by *Adsorption* on activated charcoal (granular activated carbon). A form of *Tertiary Wastewater Treatment*.

Carbon Treatment — (Water Quality) In a drinking water purification process, the removal of *Colloids* by *Adsorption* on *Activated Charcoal*. This step often improves the color, taste, and odor of drinking water. Also see *Secondary Drinking Water Standards*.

Carbonaceous Biochemical Oxygen Demand — The incubation of a sample of water or wastewater for a relatively short period of time in order to determine the *Biochemical Oxygen Demand (BOD)*. The short incubation, usually 5 days, is sufficient to detect only the microbial utilization of carbon compounds. A longer incubation (15 to 20 days) would also detect the oxidation of inorganic nitrogenous compounds (ammonia and nitrite) and the subsequent demand for molecular oxygen by chemoautotrophic bacteria.

Carbonaceous Stage — A stage of decomposition that occurs in biological treatment processes when aerobic bacteria, using dissolved oxygen, change carbon compounds to carbon dioxide. Sometimes referred to as “first stage BOD” (*Biochemical Oxygen Demand*) because the microorganisms attack organic or carbon compounds first and nitrogen compounds later. Also see *Nitrification Stage*.

Carbonate — (1) Mineral formed by the combination of the complex ion $(\text{CO}_3)^{2-}$ with a positive ion, for example, CaCO_3 . (2) A sediment formed by the organic or inorganic precipitation from aqueous solution of carbonates of calcium, magnesium, or iron. (3) The collective term for the natural inorganic chemical compounds related to carbon dioxide that exist in natural waterways. (4) A sediment formed by the organic or inorganic precipitation from aqueous solution of carbonates of calcium, magnesium, or iron. The CO_3^{2-} ion in the *Carbonate Buffer System*. Combined with one proton, it becomes *Bicarbonate*, HCO_3^- and with two protons, *Carbonic Acid*. The carbonate ion forms a solid precipitant when combined with dissolved ions of calcium or magnesium.

Carbonate Aquifer — An aquifer found in limestone and dolomite rocks. Carbonate aquifers typically produced hard water, that is, water containing relatively high levels of calcium and magnesium.

Carbonate Buffer System — The most important buffer system in natural surface waters and wastewater treatment, consisting of a carbon dioxide, water, carbonic acid, *Bicarbonate*, and *Carbonate* ion equilibrium that resists changes in the water's pH. For example, if acid materials (hydrogen ions) are added to this buffer solution, the equilibrium is shifted and carbonate ions combine with the hydrogen ions to form bicarbonate. Subsequently, the bicarbonate then combines with hydrogen ions to form carbonic acid, which can dissociate into carbon dioxide and water. Thus the system pH is unaltered even though acid was introduced.

Carbonate Compensation Depth — (Oceanography) The depth below which the calcareous skeletons of marine animals dissolve as fast as they accumulate. Also referred to as the *Calcite Compensation Depth* or the *Calcium Carbonate Compensation Depth*.

Carbonate Hardness — Water hardness caused by the presence of *Carbonate* and *Bicarbonate* of calcium and magnesium. Also see *Temporary Hardness*.

Carbonate Rock — (Geology) A rock consisting chiefly of carbonate minerals, such as limestone and dolomite.

Carbonated Water — (1) Effervescent water, usually containing salts, charged under pressure with purified carbon dioxide gas, used as a beverage or mixer. Also referred to as soda water, club soda, or seltzer. (2) A solution of water, sodium bicarbonate, and acid.

Carbonated Spring — A spring containing carbon dioxide gas in solution.

Carbonation, Groundwater — The dissolving of carbon dioxide in surface water as it percolates through the ground. The carbon dioxide reacts with water to form carbonic acid, a weak acid that causes the water to have a slightly acidic pH.

Carbonic Acid — A weak, unstable acid, H_2CO_3 , present in solutions of carbon dioxide and water. The carbonic acid content of natural, unpolluted rainfall lowers its pH to about 5.6.

Carcinogen — A cancer-causing substance or agent. Any substance which tends to produce cancer in an organism.

Carcinogenic — Cancer causing or producing.

Carlson's Trophic State Index (TSI) — (1) A numerical index for estimating lake *Trophic State* (i.e., *Eutrophication*) on a scale of 0 to 100 with each increase of 10 in the index representing a doubling of algal biomass. (2) A measure of eutrophication of a body of water using a combination of measures of water transparency or turbidity (using *Secchi Disk* depth recordings), *Chlorophyll-a* concentrations, and total phosphorus levels. TSI measures range from a scale 20–80 and from *Oligotrophic* waters (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hyper-eutrophic* waters (minimum transparency, maximum chlorophyll-a, maximum phosphorus). (3) The most widely used index for eutrophication in lake monitoring programs, and is based on epilimnetic chlorophyll a concentration, total phosphorus concentration (P), and Secchi depth. Index values range from below 0 (ultraoligotrophic) to above 100 (hypereutrophic). Each of three measures (chlorophyll, total P, Secchi) is used to calculate an independent index, and the indices can be compared to identify whether algal growth is limited by phosphorus, light, or other nutrients. Chlorophyll is the most accurate and is the preferred indicator of trophic state. Total phosphorus and Secchi depth indices are also used as surrogates in the absence of chlorophyll data, and can be used to identify factors contributing to algal growth when all three are measured. Also referred to as the (*Mean*) *Trophic State Index (TSI)*. Also see *Total Inorganic Nitrogen (TIN)* and *Total Inorganic Phosphate (TIP)*.

Carr, also Car — (1) A pool; also, a *Fen* or a *Bog*. (2) The yellow or brown sediment of humate of iron in water flowing from a peaty bog.

Carriage Losses (Water) — A term used to describe the operational losses associated with conveying water from its point of

diversion to its point of use. These losses typically include spillage, seepage, evaporation, and phreatophyte useage along the water course, as applicable. Water rights applicants are entitled to water for transporting their entitlement to their proposed place(s) of use. Carriage losses are generally considered unavoidable, and are legally bearable so long as that extra water is used reasonably and economically in transporting the water to its destination.

Carriage Water (California–Central Valley Project) — The amount of extra water required for *Sacramento-San Joaquin Delta* outflow to maintain water quality standards in the Delta as the result of an increase in exports. Also see *Bay-Delta [California]*.

Carrying Capacity — (Ecology) The maximum number and type of species which a particular habitat or environment can support without detrimental effects.

Carryover (Carry-Over) — The portion of stream flow during a given month or year that is derived from precipitation from earlier periods.

Carson Division [Newlands Project, Nevada] — The Carson Division of the Newlands Project is located entirely within Churchill County, Nevada. It contains about 67,840 acres of water-righted land and is supplied by a combination of Carson River and Truckee River water from Lahontan Reservoir.

Carville Decree [Nevada] — The Carville Decree was issued on January 24, 1935 by Judge E.P. Carville and adjudicated water rights for the Little Humboldt River. As with the 1931 *Bartlett Decree* (and the 1935 *Edwards Decree* modifying the Bartlett Decree), the Carville Decree determined water rights for three classes of lands: (1) Class A – harvest crops; (2) Class B – meadow pasture; and (3) Class C – diversified pasture. In general, the decree provided for a flow of 1.0 cfs per 100 acres of decreed land, or at rates proportional to this. When water was available, Class A water rights are for the delivery of water at this rate of flow for a period of 180 days from March 15 to September 15, or a total water diversion during the season of 3.6 acre-feet per acre. Class B rights are for 90 days from March 15 to June 13, for a total of 1.8 acre-feet per acre. Class C rights are for 45 days from March 15 to April 28, for a total of 0.9 acre-feet per acre.

CAS Registration Number — A number assigned by the Chemical Abstracts Service (CAS) to identify a chemical.

Cascade — (1) A short, steep drop in stream bed elevation often marked by boulders and agitated white water. (2) A small, steep waterfall, especially one that is part of a series of such falls descending over steeply slanting rocks. (Geology) (3) A short, rocky downward slope in a stream bed over which water flows faster than through a rapids. (4) A glacial valley whose floor resembles a broad staircase with irregular benches separated by steep risers. Also referred to as a *Glacial Stairway*.

Cascade Flow — Regulated flow through a series of flow control structures.

Cascading Glacier — A glacier having many crevasses as a result of passing over a steep, irregular bed.

Casing — (1) A tubular structure, generally of metal, concrete, or thermoplastic, which is installed in the hole to maintain the well opening. (2) The steel conduit required to prevent waste and contamination of the groundwater and to hold the formation open during the construction or use of the well. A tubular structure intended to be water tight installed in the excavated or drilled hole to maintain the well opening and, along with cementing, to confine the groundwaters to their zones of origin and prevent the entrance of surface pollutants.

Casual Water — A temporary accumulation of water not forming a regular hazard of a golf course.

Catabolism — The biological breakdown of materials into their simpler components, i.e., decomposition. Performed by decomposer organisms, mainly bacteria and fungi.

Catadromous — Used to describe fish that are born in salt water, move to and live in fresh water, but migrate back to marine waters to breed. Contrast with *Anadromous*.

Catalase — A red crystalline enzyme that consists of a protein complex with heme groups and catalyzes the decomposition of *Hydrogen Peroxide* into water and oxygen.

Catalysis — The action of a *Catalyst*, especially an increase in the rate of a chemical reaction.

Catalyst — A substance that changes the speed or yield of a chemical reaction without being consumed or chemically changed by the chemical reaction. For example, *Enzymes* are biological catalysts, enhancing reactions within living organisms.

Catalytic Converter — (1) A reaction chamber typically containing a finely divided platinum-iridium *Catalyst* into which exhaust gases from an automotive engine are passed together with excess air so that carbon monoxide and hydrocarbon pollutants are oxidized to carbon dioxide and water. (2) A sealed container having no moving parts, inserted in the exhaust system of an internal combustion engine to convert the three chemical pollutants contained in automotive exhaust (unburned hydrocarbons, carbon monoxide and oxides of nitrogen) into water, carbon dioxide and nitrogen. Conversion is accomplished by passing exhaust gases through a catalyst, a benign substance whose presence accomplishes conversion.

Catalyze — To act as a catalyst or to speed up a chemical reaction. To modify, especially to increase, the rate of a chemical reaction by *Catalysis* or the action of a *Catalyst*.

Catalyzed — To be acted upon by a catalyst.

Cataphoresis — The migration of charged colloidal particles (*Colloids*) or *Molecules* through a solution under the influence of an applied electric field usually provided by immersed electrodes. Also call *Electrophoresis*.

Cataract — (1) A large-volume waterfall whose vertical descent is concentrated in one sheer drop. (2) A series of steep rapids within a large river. (3) A large rush of water; a flood.

Catastrophic — A property of non-linear dynamic systems (such as *Biotic Communities*) in which what appears to be a small disturbance (introduction of an exotic species) initiates large changes and establishes a new set of stable conditions.

Catch Basin — A sieve-like device at the entrance to a sewer to stop matter that could possibly block up the sewer.

Catchment — (1) The catching or collecting of water, especially rainfall. (2) A reservoir or other basin for catching water. (3) The water thus caught.

Catchment Area — (1) The intake area of an aquifer and all areas that contribute surface water to the intake area. (2) The areas tributary to a lake, stream, sewer, or drain. (3) A reservoir or basin developed for flood control or water management for

livestock and/or wildlife. See also *Drainage Area*; *Watershed*.

Catchment Area (Basin) — The area draining into a river, reservoir, or other body of water.

Categorical Exclusion — (1) A class of actions which either individually or cumulatively would not have a significant effect on the human environment and therefore would not require preparation of an *Environmental Assessment (EA)* or an *Environmental Impact Statement (EIS)* under the *National Environmental Policy Act (NEPA)*. (2) A class of actions, defined and approved in accordance with Executive Order 12114, DOD Directive 6050.7 and service regulations, that normally do not, individually or cumulatively, significantly harm the environment and which require no further environment review beyond appropriate documentation of the decision to apply the exclusion.

Categorical Limits — (Wastewater Treatment) Industrial wastewater discharge pollutant effluent limits developed by the *U.S. Environmental Protection Agency (EPA)* that are applied to the effluent from any industry in any category anywhere in the United States that discharges to a *Publicly-Owned Treatment Works (POTW)*. These are pollutant effluent limits based on the technology available to treat the wastestreams from the processes of the specific industrial category and normally are measured at the point of discharge from the regulated process. The pollutant effluent limits are listed in the *Code of Federal Regulations (CFR)*.

Categorical Pretreatment Standard — A technology-based effluent limitation for an industrial facility discharging into a municipal sewer system. Analogous in stringency to *Best Available Technology (BAT)* for direct dischargers.

Categorical Standards — (Wastewater Treatment) Industrial waste discharge standards developed by *U.S. Environmental Protection Agency (EPA)* that are applied to the effluent from any industry in any category anywhere in the United States that discharges to a *Publicly Owned Treatment Works (POTW)*. These are standards based on the technology available to treat the wastestreams from the processes of the specific industrial category and normally are measured at the point of discharge from the regulated process. The standards are listed in the *Code of Federal Regulations (CFR)*.

Categorical Variable — (Statistics) A qualitative variable created by classifying observations into categories. For example, a series of household incomes could be classified into the categorical variables low, medium, and high describing certain specific ranges of income levels. Many statistical techniques are inappropriate for the use of categorical variables. Also referred to as a *Qualitative Variable*. Contrast with *Quantitative Variable*.

Cathode — The negative pole or electrode of an electrolytic cell or system. The cathode attracts positively charged particles or ions (cations).

Cathodic Protection — An electrical system for prevention of rust, corrosion, and pitting of metal surfaces which are in contact with water or soil. A low-voltage current is made to flow through a liquid (water) or a soil in contact with the metal in such a manner that the external electromotive force renders the metal structure cathodic. This concentrates corrosion on auxiliary anodic parts which are deliberately allowed to corrode instead of letting the structure corrode.

Cathole — A localism used by early settlers in southern Michigan for very small (usually less than an acre) shallow depressions or holes. The name presumably originated from the characteristic aquatic plant, the cattail, (*Typha* spp.). Later, the term came to be applied loosely to any shallow boggy or miry depression especially in the till clay plains. These depressions represented minor inequalities in the plains left by the ice sheet and were originally numerous but have been largely obliterated by land clearing and land drainage. The term cathole is also an old colloquialism for a hole or pond, in a stream, or swamp, frequented by catfish.

Cation — (1) A positive ion. An ion having a positive charge and, in electrolytes, characteristically moving toward a negative electrode. (2) The positively charged particle or ion in an electrolyzed solution which travels to the cathode and is there discharged, evolved, or deposited. Also, by extension, any positive ion.

Cation Exchange — A chemical process in which *Cations* of like charge are exchanged equally between a solid, such as zeolite, and a solution, such as water. The process is often used to soften water. Sodium ion (Na⁺) is a cation.

Cation Exchange Capacity (CEC) — The total of exchangeable cations that a soil can adsorb; expressed in milliequivalents per 100 grams (g) of soil.

Cationic Polymer — A polymer having positively charged groups of ions; often used as a coagulant aid.

Cat's-Paw, also Catspaw — A light breeze that ruffles small areas of a water surface.

Cattail — A tall, reedy marsh plant with brown furry fruiting spikes; an *Emergent Plant*.

Causeway — A raised roadway, as across water or marshland.

Caustic — Alkaline or basic.

Cavendish, Henry (1731–1810) — A British chemist and physicist who discovered the properties of hydrogen and established that water was a compound of hydrogen and oxygen.

Cavern — A large underground opening in rock (usually limestone) which occurred when some of the rock was dissolved by water. In some igneous (formed by volcanic action) rocks, caverns can be formed by large gas bubbles.

Caving — The collapse of a stream bank by undercutting due to wearing away of the toe or an erodible soil layer above the toe.

Cavitation — (1) A process of erosion in a stream channel caused by sudden collapse of vapor bubbles against the channel wall. (2) The formation of cavities filled with air and water vapor due to internal pressure reduced below atmosphere. (3) The formation and collapse of gas pockets or bubbles on the blade of an impeller or the gate of a valve; collapse of these pockets or bubbles drives water with such force that it can cause pitting of the gate or valve surface. (4) A phenomena of cavity formation, or formation and collapse, especially in regard to pumps, when the absolute pressure within the water reaches the vapor pressure causing the formation of vapor pockets. (5) The formation and collapse of a gas pocket or bubble on the blade of an impeller or the gate of a valve. The collapse of this gas pocket or bubble drives water into the impeller or gate with a terrific force that can cause pitting on the impeller or gate surface. Cavitation is accompanied by loud noises that sound like someone is pounding on the impeller or gate with a hammer.

Cay — A low island or reef of sand or coral.

Cell — (Biology) The basic building block of all living matter. The cell of a living organism contains a high percentage of water.

Cells/Volume — The number of plankton cells or natural units counted using a microscope and grid or counting cell. Results are generally reported as cells or units per milliliter.

Cells Volume (Biovolume) — One of several common methods used to estimate biomass of algae in aquatic systems. Cell members of algae are frequently used in aquatic surveys as an indicator of algal production. However, cell numbers alone cannot represent true biomass because of considerable cell-size variation among the algal species. Cell volume (μm^3) is determined by obtaining critical cell measurements on cell dimensions (for example, length, width, height, or radius) for 20 to 50 cells of each important species to obtain an average biovolume per cell. Cells are categorized according to the correspondence of their cellular shape to the nearest geometric solid or combination of simple solids (for example, spheres, cones, or cylinders). Representative formulae used to compute biovolume are as follows: (1) sphere: $4/3 \pi r^3$; (2) cone: $1/3 \pi r^2 h$; (3) cylinder: $\pi r^2 h$. From cell volume, total algal biomass expressed as biovolume ($\mu\text{m}^3/\text{mL}$) is thus determined by multiplying the number of cells of a given species by its average cell volume and then summing these volumes overall all species.

Cellulose — The fibrous part of plants used in making paper and textiles, which in turn may be made into building products.

Celsius (Temperature Scale, C) — (1) Relating to, conforming to, or having the international thermometric scale on which the interval between the triple point of water and the boiling point of water is divided into 99.99 degrees with 0.01° representing the *Triple Point* and 100° the boiling point at one atmosphere of pressure; Abbreviation C; Compare to *Centigrade [Temperature Scale]*. The Celsius scale, which is identical to the Centigrade scale, is named for the 18th-century Swedish astronomer Anders Celsius, who first proposed the use of a scale in which the interval between the freezing and boiling points of water is divided into 100 degrees. By international agreement, the term Celsius has officially replaced Centigrade. (2) Unit of measure for the *Centigrade Temperature Scale* of measuring temperature, as contrasted with the *Fahrenheit* unit of measure. The formula for converting a Celsius temperature to Fahrenheit temperature is $FE = [9/5CE + 32]$. Also see *Temperature Scale*.

Cement Grout — A mixture consisting of a high-sulfate-resistant type Portland cement and no more than six gallons of water for each 94-pound sack of cement.

Cementing — The process of mixing and placing cement grout in a hole to prevent the vertical movement of fluids in the hole or the annulus. Also see *Grouting*.

Cenozoic Era — Of, belonging to, or designating the latest era of geologic time, extending from 65 million years before present (B.P.) to the present, and including the *Tertiary Period* (from 65 million years B.P. to about 2 million years B.P.), encompassing the Paleocene, Eocene, Oligocene, Miocene and Pliocene Epochs, and the *Quaternary Period* (from about 2 million years B.P. to the present), encompassing the Pleistocene and Holocene Epochs, and is characterized by the formation of modern continents, glaciation, and the diversification of mammals, birds, and plants. See *Geologic Time (History)*.

Centralized Waste Treatment (CWT) Facility — A facility designed to properly handle treatment of specific hazardous wastes from industries with similar wastestreams. The wastewaters containing the hazardous substances are transported to the facility for proper storage, treatment and disposal. Different facilities treat different types of hazardous wastes.

Census — A complete counting, with classification, of a population or group at a particular point in time, as regards to some well-defined characteristic(s). Usually has governmental and economic and social connotations, e.g., the decennial census of the population; however, also used in a biological and environmental sense for plants, animals, and habitat.

Census of Agriculture — A *Census* taken by the U.S. Department of Commerce, Bureau of the Census, every 5 years to include the number of farms, land in farms, crop acreage and production, irrigated acreage, farm spending, farm facilities and equipment, farm tenure, value of farm products sold, farm size, and other farm-related data.

Census X-11 (Seasonal Adjustment) Process — (Statistics) A seasonal adjustment process for decomposing time series data into its trend-level, seasonal index, trading day, and irregular components. It is primarily used to *De-Seasonalize* official government statistics for publication, but is arguably the most widely used and accepted seasonal adjusted process.

Center for Wetlands [University of Florida] — The Center for Wetlands, located on the campus of the University of Florida in Gainesville, Florida, was the first of its kind in the world. Founded in 1973 by H.T. Odum, the Center's has been to serve as a focal point for both basic ecological research on wetlands as well as their sustainable use in meeting environmental management needs of the society. The Center soon became the forum for interfacing traditional engineers with ecologists, especially regarding the use of natural and constructed wetlands for wastewater treatment. Not only was the Center the first academic organization to propose and implement the use of natural wetland systems for waste treatment, but this effort was largely responsible for the development of the entire field of ecological engineering. Currently, such "green" engineering has become the focus of major engineering schools throughout northern and central Europe. The Center's fundamental research and educational efforts include:

- [1] Wetlands Ecology
- [2] Ecological Engineering
- [3] Environmental Policy
- [4] Wetlands Database

The Center is actively involved in research in several areas of wetlands ecology, to include:

- Constructed wetlands and plant succession;
- Benthic macroinvertebrates and the development of biotic indices;
- Effects of deforestation and other human impacts on wetlands;
- Fish ecology and adaptations to low oxygen environments; and
- Nutrient uptake in wetland plants.

Center-Pivot Irrigation — Automated sprinkler irrigation achieved by automatically rotating the sprinkler pipe or boom, supplying water to the sprinkler heads or nozzles, at a radius from the center of the field to be irrigated. Water is delivered to the center or pivot point of the system. The pipe is supported above the crop by towers at fixed spacings and propelled by pneumatic,

mechanical, hydraulic, or electric power on wheels or skids in fixed circular paths at uniform angular speeds. Water is applied at a uniform rate by progressive increase of nozzle size from the pivot to the end of the line. The depth of water applied is determined by the rate of travel of the system. Single units are ordinarily about 1,250 to 1,300 feet long (381–397 meters) and irrigate approximately a 130-acre (52.7 hectare) circular area. Also see *Irrigation Systems*.

Centigrade (Temperature Scale, C) — Relating to, conforming to, or having a thermometric scale on which the interval between the freezing point of water and the boiling point of water is divided into 100 degrees with 0° representing the freezing point and 100° the boiling point at one atmosphere of pressure; Abbreviation C; Compare to *Celsius [Temperature Scale]*. The Centigrade scale is identical to the Celsius scale; however, by international agreement, the term Celsius has officially replaced Centigrade. Contrast with the *Fahrenheit Temperature Scale*, using degrees *Fahrenheit* (EF), in which 32EF above the 0E(F) mark indicates the freezing point of water and 212EF indicates the boiling point of water (at sea level). Also see *Temperature Scale*.

Central Valley [California] — A vast oblong valley located in the interior of the State of California extending 400 miles north and south and 50 miles east and west from Redding in the north to Bakersfield in the south. The valley is bordered by the Cascade and Sierra Nevada ranges on the east and the Coast Range on the west. The valley consists of three major drainage areas: (1) the Sacramento River in the north; (2) primarily the San Joaquin River in the south; and (3) an area of convergence of these two river systems in the central part of the valley consisting of a 1,153-square mile maze of channels and islands referred to as the Sacramento-San Joaquin Delta, or more commonly as the “Delta”. The valley’s rich soils and Mediterranean climate, with mild temperatures and long, dry summers, provide ideal growing conditions for a variety of fruits and vegetables. This area has become the most productive agricultural region in the world and the richest agricultural area in the nation, irrigating more than 3 million acres of land and producing more than \$3.5 billion in crops. The Central Valley once constituted an immense seasonal wetland that regularly flooded from the Sierra foothills in the east to the Coast Range in the west. Since the arrival of European settlers, this area has been forever transformed by settlement, agricultural development, and flood control and reclamation projects. It has been estimated that approximately 3.6 million acres of marsh and overflow land have been dried up since the 1800’s, constituting a reduction of more than 90 percent of the Central Valley’s original wetlands. A fundamental problem with this area now is that the availability of water decreases significantly as one travels from north to south through the valley. Water transfers have therefore become the norm in the Central Valley due to the fact that 75 percent of California’s annual precipitation falls north of the Delta while 75 percent of the farming and urban water needs are south of the Delta, with particularly heavy water demand for both agriculture in the San Joaquin Valley and municipal water demand in southern California. As a consequence, this area has become the center for an extensive water storage, diversion, and transfer program consisting of the federally-funded *Central Valley Project (CVP)* and the state-funded *State Water Project (SWP)*. Together, these two water projects have resulted in one of the largest water storage and transport systems in the world extending 450 miles from Lake Shasta in northern California to Bakersfield in the southern San Joaquin Valley. The Central Valley also contains California’s largest and most heavily used groundwater basins. Extensive sediments of up to 50,000 feet thick are found in the Sacramento Valley and up to 32,000 feet in the southern Tulare Basin. These layers of alluvium now form vast fresh water underground aquifers capped with fertile topsoil. Also see *Central Valley Project Improvement Act (CVPIA)*.

Central Valley Project (CVP) [California] — A multipurpose water project extending throughout California’s *Central Valley* and developed primarily by the *U.S. Bureau of Reclamation (USBR)*. The Central Valley Project represents one of the USBR’s most ambitious projects built to tame the Central Valley’s floodwaters and irrigate the semi-arid acreage of this vast valley. Since its inception in 1937, the CVP has grown to become one of the largest water storage and transport systems in the world. The CVP extends from the drainages located in the Cascade Range in northern California’s Sacramento Valley to the semiarid but fertile plains of California’s Kern River in the southern part of the San Joaquin Valley. The need for the CVP was based on a severe drought which greatly affected Central Valley farmers from 1928 through 1934. The CVP was originally authorized as a state-funded and owned water project through the 1933 passage of the California Central Valley Project Act. However, the state’s inability to raise funds during the Great Depression forced the state to turn to the federal government for funding. With the passage of the Rivers and Harbors Act of 1935, the federal government assumed control of the project. Its initial features were authorized for construction by the *U.S. Army Corps of Engineers*. When the act was reauthorized in 1937, the USBR took over CVP construction and operation and the project became subject to reclamation law. Under the 1937 act, the CVP’s water storage, hydropower, and distribution facilities had three purposes: (1) regulate rivers and improve flood control and navigation; (2) provide water for irrigation and domestic use; and (3) generate electrical power. Under later legislation, e.g., the *Central Valley Project Improvement Act (CVPIA)*, additional project purposes were added, for example, recreation, fish and wildlife enhancement, and water quality enhancements. The CVP encompasses 20 dams and reservoirs capable of storing 11 million acre-feet of water, 11 hydroelectric power plants (and 38 generators), pumping facilities, 500 miles of major canals and aqueducts, three fish hatcheries, and assorted tunnels, conduits, power transmission grids and distribution systems. CVP facilities also provide protection from saltwater intrusion into the *Bay-Delta* region (also referred to as the *Sacramento-San Joaquin Delta* or merely the Delta), maintain fresh water supplies for Delta farms, irrigation water for San Joaquin Valley farms, and municipal and industrial water for some of California’s most populated urban areas. Each year some seven million acre-feet of water are transported through the system and delivered primarily to Central Valley farmers. Principle facilities of the CVP include Shasta Dam and Reservoir, the Shasta Powerplant, Keswick Dam, reservoir and powerplant, Coleman National Fish Hatchery, Friant Dam, Friant-Kern Canal and Madera Canal, Mendota Pool, the Delta-Mendota Canal, the Delta Cross Channel, Tracy Pumping Plant and the Tracy Fish Collecting Facility. Other major CVP facilities include the Trinity Dam, Lewiston Dam, Whiskeytown Reservoir, Spring Creek Debris Dam, Red Bluff Diversion Dam, the Tehama-Colusa and Corning canals, Folsom Dam and Powerplant, Nimbus Dam, Nimbus Powerplant, the Nimbus Salmon and Steelhead Hatchery, the Folsom South Canal, the New Melones Dam, and various Delta facilities. Supplemental facilities to this effort were later constructed by California after the Great Depression as part of the *State Water Project (SWP)* as authorized under the 1960 Burns-Porter Act. Principal facilities

- of the SWP include Oroville Dam, Delta Facilities, the California Aqueduct, and North and South Bay Aqueducts. Joint CVP/SWP facilities include San Luis Dam and San Luis Reservoir, the San Luis Canal, and various other *Bay-Delta* facilities.
- Central Valley Project Improvement Act (CVPIA) (Public Law 102-575) [California]** — A federal act passed in 1992 as part of the Reclamations Projects Authorization and Adjustment Act and intended on reforming *Central Valley Project (CVP)* water policies, pricing, and distribution. The act also established an anadromous fish restoration program and an annual \$50 million environmental restoration fund financed by surcharges on CVP water and power sales in order to mitigate environmental impacts of the project. One of the most ambitious components of the CVPIA was its Anadromous Fishery Restoration Program (AFRP). This program was intended to double the natural production of fish that migrate between fresh water and salt water with a goal to at least double average population levels of salmon, steelhead, striped bass, American Shad, white sturgeon, and green sturgeon by the year 2002 from average population levels of 1967-1991.
- Central Water** — (Oceanography) A subdivision of the surface group of water masses, found in the temperate climatic zones and characterized by high salinity and fairly warm temperatures.
- Centralized Control (Canal)** — Control of a canal project from a central location by the watermaster.
- Centralized Headquarters (Canal)** — Control of a canal project from a central location generally by a master station, communications network, and one or more remote terminal units (RTUs).
- Centralizer** — A device used to center the casing in the hole.
- Centrate** — The water leaving a centrifugal after most of the solids have been removed.
- Centrifugal Drainage Pattern** — See *Radial Drainage Pattern*.
- Centrifugal Pump** — (1) A device that converts mechanical energy to pressure or kinetic energy in a fluid by imparting centrifugal force on the fluid through a rapidly rotating impeller. (2) A pump consisting of an impeller fixed on a rotating shaft that is enclosed in a casing, and having an inlet and discharge connection. As the rotating impeller whirls the water around, centrifugal force builds up enough pressure to force the water through the discharge outlet.
- Centrifugation** — (Water Quality) In water and wastewater treatment, a method used to remove liquid from sludges through use of centrifugal forces.
- Centrifuge** — A mechanical device that uses centrifugal or rotational forces to separate solids from liquids.
- CEQA** — See *California Environmental Quality Act (CEQA)*.
- CERCLA** — See *Comprehensive Environmental Response, Compensation, and Liability Act*.
- CERES** — See *California Environmental Resources Evaluation System*.
- Certificate of Water Right** — An official document which serves as evidence of a *Perfected Water Right*. Also see *Application, Water Right*.
- Certificated Water Right** — The right granted by a state water agency to use either surface or groundwater. Also see *Application, Water Right* and *Vested Water Right*.
- Certificated Water Right [Nevada]** — The right to put surface or groundwater to beneficial use that is identified by a recorded document issued by the Nevada State Engineer after satisfactory proof of “perfection of application” for a permitted water right has been filed in accordance with Nevada Revised Statutes Chapter 533.
- Certified Water Right** — A state-issued document that serves as legal evidence that an approved application has been physically developed and the water put to beneficial use. The certificate establishes priority date, type of beneficial use, and the maximum amount of water that can be used. Before a water right can be certified, verification of the physical development must be provided to the state through a survey conducted by an approved water rights examiner. Even certified water rights are subject to occasional review to ensure continued beneficial use.
- Cesspool** — (1) An underground catch basin for combined liquid and solid waste, such as household sewage, so designed as to retain the organic matter and solids but permitting the liquids to seep through the bottom and sides. (2) A lined or partially lined excavation or pit for dumping raw household wastewater for natural decomposition and percolation into the soil. Also see *Septic Tanks*.
- CF** — Calcium (hardness) Factor.
- CFR** — See *Code of Federal Regulations*.
- CFS (Cubic Foot per Second)** — (1) Cubic feet per second. Sometimes referred to as second feet. A unit of water flow used to indicate the volume of water flowing per second past any given point along a river. A unit of discharge for measurement of flowing liquid equal to a flow of one cubic foot per second past a given section. A rate of flow equivalent to 448.83 gallons per minute. Also called *Second-Foot*. Also written as C.F.S. and cfs.
- CFS-Day** — The volume of water represented by a flow of 1 cubic foot per second for 24 hours. It equals 86,400 cubic feet, 1.983471 acre-feet, or 646,317 gallons.
- CFSM (Cubic Feet per Second per Square Mile)** — The average number of cubic feet of water per second flowing from each square mile of area drained by a stream, assuming that the runoff is distributed uniformly in time and area.
- CFU** — See *Colony Forming Units*.
- Chain of Lakes** — A number of lakes tied together by live connecting streams or natural channels.
- Chain of Life** — The system whereby little fish are consumed by larger fish, etc., until the offal or body of some higher life-form returns to dust or ooze.
- Chalk** — A mineral composed mainly of the calcareous shells of various marine microorganisms, but whose matrix consists of fine particles of calcium carbonate, some of which may have been chemically precipitated.
- Chalybeate** — Tasting like iron, as water from a mineral spring.
- Change in Storage** — The difference between the amount of water flowing into a reservoir or other body of water and the amount flowing out.

- Channel** — (Watercourse) (1) A natural bed or an open, artificial conduit in which a body of water runs or may run, either continuously or periodically. (2) A natural passageway or water course connecting two bodies of water. (3) A natural stream that conveys water; a natural or artificial watercourse with definite bed and banks to confine and conduct flowing water; a ditch or channel excavated for the flow of water. River, creek, run, branch, anabranch, and tributary are some of the terms used to describe natural channels, which may be single or *Braided*. Canal, aqueduct, and floodway are some of the terms used to describe artificial (man-made) channels. (Geology) (4) A buried or abandoned water course that is indicated by the presence of gravel or sand deposits. (5) The bed of a single or braided watercourse that commonly is barren of vegetation and is formed of modern alluvium. Channels may be enclosed by banks or splayed across and slightly mounded above a fan surface and include bars and dumps of cobbles and stones. Channels, excepting floodplain playas, are landform elements. (6) A wide *Strait*. (Navigation) (7) The central or deepest part of a river or stream that carries the main flow. (8) A navigable or raftable route through a section or reach of a river.
- Channel (Lake)** — In instances sub-lacustrine channels appear where a lake has been formed by the submergence of a valley, or the drowning of a river; the channels formed under subaerial conditions by stream cutting may remain unfilled by sediments, on the lake bottom. Channel is applied to a surface water way, either natural or artificial, which connects two lakes and provides for boat travel; to river distributaries and connecting water in a delta; and to trench-like excavations extended inland from a lake shoreline to provide water frontages and boat access for back lots.
- Channel (Lake Basin)** — The deeper, narrow elongated or more sharply trenched part of a lake bottom.
- Channel Bank** — The sloping land bordering a channel. The bank has steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.
- Channel Capacity** — (1) The maximum flow that can be carried by a given channel without overflowing its banks. (2) The maximum rate of flow that may occur in a stream without causing overbank flooding; the maximum flow which can pass through a channel without overflowing the banks.
- Channel Control** — (1) A condition in which the stage of a stream is influenced only by discharge and the contours of the stream's bed, banks, and floodplains. (2) The condition under which the stage-discharge relation of a gaging station is governed by the slope, size, geometry, and roughness of the channel.
- Channel Density** — The ratio of the length of stream channels in a given basin to the area of the basin, expressed in feet per acre (meters per hectare).
- Channel Fills** — In valley sediment deposition, channel fills consist of accumulations in abandoned or aggrading channel segments; ranging from relatively coarse bed load to fine-grained oxbow lake deposits. See *Valley Sediment Deposits*.
- Channel Flow** — Surface runoff that moves through a long, narrow depression that is bounded by banks or valley walls. Also referred to as *Concentrated Flow*.
- Channel-Forming Discharge** — See *Dominant Discharge*.
- Channel Frequency** — See *Stream Frequency*.
- Channel Gradient Ratio** — See *Stream Gradient Ratio*.
- Channel Inflow** — Water which at any instant is flowing into the channel system from surface flow, subsurface flow, base flow, and rainfall directly on the channel.
- Channel Line** — The line of the strongest flow or fastest current of a stream.
- Channel Lining** — Protection of the channel bottom and banks with concrete or *Riprap*.
- Channel Modification** — The modification of the flow characteristics of a channel by clearing, dredging, excavation, realignment, lining, or other means to increase its capacity. Sometimes the term is used to connote *Channel Stabilization*.
- Channel Net** — The pattern made by all stream channels within a particular drainage basin. Also referred to as *Channel Network*.
- Channel Order** — See *Stream Order*.
- Channel Pattern** — An aerial view showing the configuration of a limited reach of a river channel. Also referred to as *River Pattern*.
- Channel Realignment** — The construction of a new channel or a new alignment which may include the clearing, snagging, widening, and/or deepening of the existing channel.
- Channel Segment** — See *Stream Segment*.
- Channel Spring** — A depression spring issuing from the bank of a stream whose channel is below the water table.
- Channel Stabilization** — Erosion prevention and stabilization of velocity distribution in a channel using jetties, drops, revetments, vegetation, and other measures.
- Channel Storage** — The volume of water at a given time in the channel or over the flood plain of the streams in a drainage basin or river reach. Channel storage is sometimes significant during the progress of a flood event.
- Channelization** — (1) The artificial enlargement or realignment of a stream channel. (2) Straightening a stream or river to allow water to travel through the area more quickly. (3) Straightening of a stream or the construction of a new channel to which the stream is diverted. (4) The process of changing an straightening the natural path of a waterway. Channelization is often used as a means of flood control, but its negative effects often outweigh its advantages. For example, channelization often damages wetlands associated with rivers and streams.
- Chaos Theory** — A modern development in mathematics and science that provides a framework for understanding irregular or erratic fluctuations in nature. Chaotic systems are found in many fields of science and engineering. Evidence of chaos occurs in models and experiments describing convection and mixing in fluids, in wave motion, in oscillating chemical reactions, and in electrical currents in semiconductors. It is also found in the dynamics of animal populations and attempts are being made to apply chaotic dynamics in the social sciences, such as the study of business cycles. A chaotic system is defined as one that shows "sensitivity to initial conditions." That is, any uncertainty in the initial state of the given system, no matter how small, will lead

to rapidly growing errors in any effort to predict its future behavior. This “sensitivity to initial conditions” will make any long-term prediction of such phenomenon virtually impossible in reality. In other words, the system is chaotic and as such its behavior can be predicted only if the initial conditions are known to an infinite degree of accuracy, which is impossible. The possibility of chaos in a natural, or deterministic, system was first envisaged by the French mathematician Henri Poincaré in the late 19th century. More recently, predictions have been made that the transition to chaotic turbulence in a moving fluid would take place at a well-defined critical value of the fluid’s velocity (or some other important factor controlling the fluid’s behavior). The term chaotic dynamics refers only to the evolution of a system in time. Chaotic systems, however, also often display spatial disorder – for example, in complicated fluid flows.

Chaparral — A type of *Biome* with hot, dry summers and rainfall mainly in the winter months. Vegetation consists of shrubs, small evergreen trees, and *sclerophyllous* species. Chaparral communities are found around the Mediterranean Sea, in central and southern California, along coastal Chile, in southern Australia, and in southern Africa.

Chara — Muskgrasses or stoneworts. An unusual type of algae that has a grown form resembling a higher plant, but a close look reveals each joint of the stem is a single cell with no connective tissue.

Charophytes — A group of green algae, visible to the naked eye, with a characteristic structure in which the “stems” are very large single cells, from which whorls of similarly constructed branches emerge. Charophytes are anchored in sediments by branching cellular systems, not roots. They often deposit marl (calcium carbonate) giving them a rough texture and the common name of “stoneworts”, though not all do this. They also have a characteristic smell, which some people describe as “garlicky”.

Chatter Mark, also Chattermark — (Geology) One of a series of short scars made by glacial drift on a surface of bedrock.

Check Dam — (1) A structure placed bank to bank downhill from a headcut on a hillslope to help revegetate a gully. (2) A small dam constructed in a gully or other small watercourse to decrease the streamflow velocity, minimize channel erosion, promote deposition of sediment, and to divert water from a channel.

Check Gate — A gate located at a check structure used to control flow.

Check Irrigation — A method of irrigation in which an area is practically or entirely surrounded by earth ridges.

Check Structure — A device or structure placed in a canal such that water must pass through, over or under it. The check structure opening or position is typically a function of the flow rate, and is adjusted to maintain a certain flow rate or water level. Check structures are necessary to dam the water up during low flows so that all turnouts upstream can receive water. Also referred to as a *Cross Regulator* or *Gate*.

Check Valve — (1) A special valve with a hinged disc or flap that opens in the direction of normal flow and is forced shut when flows attempt to go in the reverse or opposite direction of normal flow. (2) A device that provides a positive (absolute) closure which prohibits the flow of material or liquid in the opposite direction of that desired when operation of the irrigation system pumping plant or chemical injection unit fails or is shut down. See *Backflow Preventer*.

Chemical — Any fertilizer or pesticide.

Chemical Feeder — (Water Quality) A mechanical device for measuring quantities of chemical and applying them to a water at a preset rate.

Chemical Oxygen Demand (COD) — (Water Quality) (1) An indirect measure of the amount of oxygen used by inorganic and organic matter in water. The measure is a laboratory test based on a chemical oxidant and therefore does not necessarily correlate with *Biochemical Oxygen Demand (BOD)*. (2) A measure of the chemically oxidizable material in the water which provides an approximation of the amount of organic and reducing material present. The determined value may correlate with *Biochemical Oxygen Demand (BOD)* or with carbonaceous organic pollution from sewage or industrial wastes. (3) A chemical measure of the amount of organic substances in water or wastewater. A strong oxidizing agent together with acid and heat are used to oxidize all carbon compounds in a water sample. Non-biodegradable and recalcitrant (slowly degrading) compounds, which are not detected by the test for BOD, are included in the analysis. The actual measurement involves a determination of the amount of oxidizing agent (typically, potassium dichromate) that is reduced during the reaction. Also see *Total Carbon (TC)* and *Total Organic Carbon (TOC)*.

Chemical Weathering — The gradual decomposition of rock by exposure to rainwater, surface water, atmospheric oxygen, carbon dioxide and other gases in the atmosphere, as well as compounds secreted by organisms. Compare to *Physical Weathering*.

Chemigation — (1) Application of pesticides or fertilizers to farmlands through irrigation systems. (2) Any process whereby chemicals are added to irrigation water applied to land or crop or both through an irrigation system.

Chemoautotroph — An organism that utilizes oxidation of inorganic chemicals for its energy and carbon dioxide for cell growth. Also called a *Chemosynthetic Autroph*.

Chemocline — (1) The boundary separating the circulating and noncirculating layers or water masses of a lake. (2) The transition zone between layers in a *Meromictic Lake*.

Chemodynamics — The study of the transport, conversion, and fate of chemical substances in air, water, or soil, including their movement from one medium to another.

Chemosphere — The region of the upper *Atmosphere* including the *Mesosphere* and upper *Stratosphere* in which various sunlight-driven chemical reactions occur.

Chemosynthesis — The synthesis of carbohydrate from carbon dioxide and water using energy obtained from the chemical oxidation of simple inorganic compounds. This form of synthesis is limited to certain bacteria and fungi.

Chesapeake Bay — The largest inlet in the Atlantic Coastal Plain of the eastern United States. Created by the submergence of the lower courses of the Susquehanna River and its tributaries, it is 193 miles (311 kilometers) long and 3 to 25 miles (5 to 40 kilometers) wide. The southern part of the bay is bordered by Virginia and its northern part by Maryland. Its entrance from the Atlantic Ocean is flanked by Cape Charles to the north and Cape Henry to the south. Besides the Susquehanna River, major rivers emptying into the bay include the James, York, Rappahannock, Potomac, and Patuxent rivers from the west, and the

Wicomico, Nanticoke, Choptank, and Chester rivers from the east. Most of the bay's irregular eastern shore is low and marshy, while the straighter western shore consists, for long distances, of cliffs. Until the latter half of the 20th century, the Chesapeake Bay's sheltered, nutrient-rich waters supported vast populations of fish, shellfish, and other marine life. Commercial fishing and recreational activities abounded. By the 1970's, however, residential and industrial development of the surrounding land had led to significant pollution of the bay by sewage, industrial wastes, and sediment. Commercial fishing dropped off sharply during the 1970's and into the 1980's, as did recreational use of the bay. Various projects have been undertaken in an effort to reverse the environmental damage inflicted on the Chesapeake Bay from human activities. The Chesapeake Bay represents the largest estuary in the U.S. and is an incredibly complex ecosystem that includes important habitats and food webs. The Chesapeake Bay itself, its rivers, wetlands, trees, and land all provide homes, protection, or food for complex groups of species. The bay is a mixture of freshwater and saltwater (from the Atlantic Ocean) and is subject to seasonal weather, therefore plant and animal populations vary with changes in clarity (light penetration), dissolved oxygen, salinity, and water temperature, as well as human impacts. Every person who lives in the 64,000-square-mile Chesapeake Bay watershed is just a few minutes from one of more than 100,000 streams and rivers draining into the bay. Today, the biggest stressors on the ecosystem are excess nutrients, toxic/chemical contamination, air pollution, and landscape changes. Since 1983, the *Chesapeake Bay Program* partners – Maryland, Pennsylvania, Virginia, the District of Columbia, the *U.S. Environmental Protection Agency (EPA)*, and the Chesapeake Bay Commission – have been setting and meeting goals to focus on its highest priority: the restoration of the Chesapeake Bay's living resources. Along the way, there's been a call to balance the needs of the ecosystem and the needs of the people who live, work and play in the Chesapeake Bay watershed. As the Chesapeake Bay Program moves into the 21st century, citizen understanding of and involvement in the Chesapeake Bay's restoration will become increasingly important. Perhaps the most valuable function of the Chesapeake Bay region is its role as a habitat for living resources. The Chesapeake Bay and its surrounding watershed provide ideal growing conditions for numerous plants and habitat for many types of animals. Some of these plant and animal species, which also serve as *Bioindicators*, include, as examples:

- [1] **Plants** – It's estimated that more than 2,700 species of plants grow in the Chesapeake Bay watershed. Without these plants, the Chesapeake Bay ecosystem would not exist.
- [2] **Fish** – More than 295 species of fish are known to occur in the Chesapeake Bay region. This constitutes about ten percent of the total number of species of plants and animals that occupy the entire Chesapeake Bay ecosystem.
- [3] **Shellfish** – More than any other animal, the blue crab, or *Callinectes sapidus*, symbolizes the life and culture of the Chesapeake Bay region. The beautifully colored, aggressive crab supports vital commercial and recreational fisheries. The Chesapeake Bay is the largest producer of crabs in the country; it's estimated that more than a third of the nation's catch of blue crabs comes from Chesapeake Bay waters.
- [4] **Submerged Aquatic Vegetation (SAV)** – SAV plays an important ecological role to the aquatic environment by providing food and habitat for waterfowl, fish, shellfish and invertebrates; the grasses serve as nursery habitat for many species of fish, such as young spot and striped bass, which seek refuge from predators in the grass beds; additionally, blue crabs are known to hide in Chesapeake Bay grasses after molting, while still soft. The submerged grasses commonly found in areas of higher salinity in the bay include eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). Grasses commonly found in areas of lower salinity include redhead grass (*Potamogeton perfoliatus*) and sago pondweed (*Potamogeton pectinatus*).
- [5] **Lower Food Web** – The lower food web includes the benthic (plants and animals that live at the bottom of the Chesapeake Bay) and the plankton (free-floating plants and animals that inhabit the water column) communities. The plankton community is composed of *Phytoplankton* and *Zooplankton*. Phytoplankton are microscopic plants, such as algae, which are the major primary producers of the bay. Zooplankton are small animals that consume plankton and in turn are consumed by higher organisms.
- [6] **Birds** – The birds that inhabit the Chesapeake Bay and its woodland and shoreline habitats constitute some of the region's most beautiful and vulnerable species. Ospreys and bald eagles, great blue herons, laughing gulls, wood ducks, Canada geese, and American oystercatchers are a few of the most visible resident and migratory birds, but their habitat requirements and behaviors are distinct. All are intricately entwined with the Chesapeake Bay's ecosystem and each performs a different ecological function.

Chesapeake Bay Program — The Chesapeake Bay Program is the unique regional partnership that's been directing and conducting the restoration of the Chesapeake Bay since the signing of the historic 1983 Chesapeake Bay Agreement. The Chesapeake Bay Program partners include the states of Maryland, Pennsylvania, and Virginia, the District of Columbia, the Chesapeake Bay Commission, a tri-state legislative body, the *U.S. Environmental Protection Agency (EPA)*, representing the federal government, and participating advisory groups. As the largest estuary in the United States and one of the most productive in the world, the Chesapeake Bay was this nation's first estuary targeted for restoration and protection. In the late 1970's, scientific and estuarine research on the Chesapeake Bay pinpointed three areas requiring immediate attention: (a) nutrient over-enrichment; (b) dwindling underwater Bay grasses; and (c) toxic pollution. Once the initial research was completed, the Chesapeake Bay Program evolved as the means to restore this exceptionally valuable resource. Since its inception in 1983, the program's highest priority has been the restoration of the Chesapeake Bay's living resources – its finfish, shellfish, bay grasses, and other aquatic life and wildlife. Improvements include fisheries and habitat restoration, recovery of bay grasses, nutrient and toxic reductions, and significant advances in estuarine science. On June 28, 2000, the Chesapeake Bay Program partners signed the new Chesapeake 2000 Agreement, which will guide the next decade of restoration and protection efforts throughout the Chesapeake Bay watershed. The agreement commits to protecting and restoring living resources, vital habitats and water quality of the Bay and its watershed. Perhaps the most encouraging fact about this program to the future of the watershed lies in the extent of the partnerships and involvements of agencies in the restoration of the Chesapeake Bay. For example, the Chesapeake Bay Program

Partners include the State of Maryland, Commonwealth of Pennsylvania, Commonwealth of Virginia, District of Columbia, Chesapeake Bay Commission, Tri-State Legislative Body, the U.S. Environmental Protection Agency, and Participating Advisory Groups. Furthermore, signatories to the Chesapeake Bay Agreement include the Chesapeake Bay Commission, Commonwealth of Pennsylvania, Pennsylvania Department of Conservation and Natural Resources (DCNR), Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Department of Education, Pennsylvania Fish and Boat Commission, Pennsylvania Game Commission, Pennsylvania Department of Agriculture, Pennsylvania Cooperative Extension Service, Commonwealth of Virginia, Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Environmental Quality (VA DEQ), Virginia Marine Resources Commission (VMRC), Virginia Chesapeake Bay Local Assistance Department (CBLAD), Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Department of Education, Virginia Naturally, Virginia Cooperative Extension Service, Virginia Department of Forestry, Virginia Department of Agriculture and Consumer Services, District of Columbia, District of Columbia Public Schools, District of Columbia Environmental Health Administration, State of Maryland, Maryland Department of Agriculture – Office of Resource Conservation, Maryland Department of the Environment (MDE), Maryland Department of Natural Resources (MD DNR), Maryland Geological Survey (MGS), Maryland Office of Planning (MOP), Maryland Environmental Services (MES), Maryland Department of Education, Maryland Cooperative Extension Service, U.S. Environmental Protection Agency, U.S. EPA Region 3, U.S. EPA Chesapeake Bay Program Office, U.S. EPA – Mid-Atlantic Integrated Assessment, U.S. EPA National Estuary Program, U.S. EPA Office of Water, U.S. EPA Office of Air and Radiation, and the Environmental Monitoring and Assessment Program (EMAP). In addition, there are also six Non-Signatory State Partners involved in the Chesapeake watershed restoration, as well as thirty-nine Federal Agency Partners, twenty-four Academic Institution Partners, and sixteen Other Partners involved in this restoration effort. Also see *Great Lakes Program*.

Chimney — A tall column of rock on the ocean floor that is formed by the precipitation of minerals from superheated water issuing from a vent in the earth's crust and rising through the column of rock. Also see *Black Smoker*.

Chinook — A downslope wind in which the air is warmed by adiabatic (gradual) heating. Such conditions describe a warm, dry southwest wind blowing from the sea onto the coast of Oregon and Washington in the winter and spring, as well as a warm, dry wind blowing down the eastern slope of the Rocky Mountains.

Chisel Plowing — Cropland preparation by a special implement (chisel) that avoids complete inversion of the soil (as occurs with conventional moldboard plowing). Chisel plowing can leave a protective cover of crop residues on the soil surface that helps prevent erosion and improve infiltration.

Chloramines — (1) A mixture of *Ammonia* and *Chlorine* used to purify water of harmful substances. (2) Compounds formed by the reaction of hypochlorous acid (or aqueous chlorine) with ammonia. (3) Compounds containing nitrogen, hydrogen, and chlorine, formed by the reaction between hypochlorous acid (HOCl) and ammonia (NH₃) and/or organic amines in water. The formation of chloramines in drinking water treatment extends the disinfecting power of chlorine. Also referred to as *Combined Available Chlorine*.

Chlorides — Negative chlorine ions, Cl⁻, found naturally in some surface waters and groundwaters and in high concentrations in seawater. Higher-than-normal chloride concentrations in fresh water, due to sodium chloride (table salt) that is used on foods and present in body wastes, can indicate sewage pollution. The use of highway deicing salts can also introduce chlorides to surface water or groundwater. Elevated groundwater chlorides in drinking water wells near coastlines may indicate *Saltwater Intrusion*.

Chlorinated — (Water Quality) Describes water or wastewater that has been treated with either chlorine gas or a chlorine-containing compound.

Chlorinated Hydrocarbons — (Water Quality) (1) Long-lived chemicals, such as DDT, which kill a particular object, such as insects, and which persist to damage other creatures in ground, sea, and air. (2) Includes a class of persistent, broad-spectrum insecticides that linger in the environment and accumulate in the food chain. Among them are DDT, aldrin, dieldrin, heptachlor, chlordane, lindane, endrine, mirex, hexachloride, and toxaphene.

Chlorination — (1) The application of chlorine or one of its compounds to water or wastewater, often for disinfection or oxidation purposes. (2) Treating drinking water by applying *Chlorine* before or after *Ammonia*. This creates a persistent disinfectant residual. (3) The application of chlorine to water, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results (aiding coagulation and controlling tastes and odors).

Chlorinator — A device for adding a chlorine-containing gas or liquid to drinking water or wastewater.

Chlorine — (1) A chemical which destroys small organisms in water. (2) A gas, Cl₂, widely used in the disinfection of water and as an oxidizing agent. (3) A chemical used to disinfect water. Chlorine is extremely reactive, and when it comes in contact with microorganisms in water it kills them. Chlorine is added to swimming pools to keep the water safe for swimming. Chlorine is available as solid tablets for swimming pools. Chlorine is very effective against algae, bacteria, and viruses. Protozoa are resistant to chlorine because they have thick coats. Protozoa are removed from drinking water by filtration. (4) One of a group of elements classified as the halogens. Chlorine, the most common halogen, is a greenish yellow gas with an irritating odor. Chlorine is very reactive; it forms salts with metals, forms acids when dissolved in water, and combines readily with hydrocarbons. Various forms of chlorine are used to disinfect water. Chlorine is produced by the electrolysis of brine (a concentrated salt solution). Atomic number 17; atomic weight 35.45; freezing point -100.98°C; boiling point -34.6°C; specific gravity 1.56 (-33.6°C).

Chlorine Breakpoint — (Water Treatment) The point at which the chlorine dosage in a water treatment process has satisfied the *Chlorine Demand*. To eliminate the taste and odor associated with processed water, sufficient chlorine must be added to reach the breakpoint. Increasing the chlorine dose beyond the breakpoint produces a free chlorine residual, which is free to kill microorganisms. When chlorine is added to water, it first combines with constituents in the water such as iron, manganese, and

nitrites. It is important to add enough chlorine to the water initially to ensure that these constituents are oxidized and to ensure that a residual is formed to react with the ammonia and organic matter in the water. Taste and odor problems result when chlorine dosages are either below the breakpoint, or well beyond the breakpoint.

Chlorine-Contact Chamber — (Water Quality) In a wastewater treatment plant, a chamber in which effluent is disinfected by chlorine before it is discharged to the receiving waters.

Chlorine Demand — (Water Quality) (1) The amount of chlorine that must be added to purify drinking water; the amount of chlorine required to react with all dissolved and particulate materials and inorganic ammonia in the water. (2) Chlorine demand is the difference between the amount of chlorine added to water and the amount of residual chlorine remaining after a given contact time. Chlorine demand may change with dosage, time, temperature, pH, and nature and amount of the impurities in the water. Chlorine Demand (mg/L) = Chlorine Applied (mg/L) minus Chlorine Residual (mg/L).

Chlorine Demand (mg/L) — Equivalent to Chlorine Applied (mg/L) minus Residual Chlorine (mg/L).

Chlorine Requirement — The amount of chlorine which is needed for a particular purpose. Some reasons for adding chlorine are to reduce the number of coliform bacteria (*Most Probable Number*), obtaining a particular chlorine residual, or oxidizing some substance in the water. In each case a definite dosage of chlorine will be necessary. This dosage is the chlorine requirement.

Chlorine Residual — The concentration of chlorine remaining in water or wastewater at the end of a specified contact period which will react chemically and biologically. May be present as either combined or free chlorine, or both.

Chlorinity — (Oceanography) A measure of the amount of chloride and other halides by mass of seawater, defined as the amount of silver required to remove the total halogen content from a 0.3285-kg sample of sea water.

Chlorophenolic — Chlorophenolic compounds are phenolic compounds (carbolic acid) combined with chlorine.

Chlorophenoxy — A class of herbicides that may be found in domestic water supplies and cause adverse health effects. Two widely used chlorophenoxy herbicides are 2,4-D (2,4-Dichlorophenoxyacetic acid) and 2,4,5-TP (2,4,5-Trichlorophenoxy propionic acid (silvex)).

Chlorophyll — The green pigments of plants. There are seven known types of chlorophyll, *Chlorophyll a* and *Chlorophyll b* are the two most common forms. A green photosynthetic coloring matter of plants found in chloroplasts and made up chiefly of a blue-black ester.

Chlororganic — Organic compounds combined with chlorine. These compounds generally originate from, or are associated with, life processes such as those of algae in water.

Chlorosity — (Oceanography) A property corresponding to the chlorinity of seawater but expressed as grams per 20 liters.

Cholera — An infectious waterborne disease that is characterized by severe diarrhea and its resultant dehydration and electrolyte imbalance. The disease is caused by bacteria belonging to the genus *Vibrio*. Outbreaks are associated with contamination of surface waters with human fecal material.

Chop — A short, irregular motion of waves. Also, an area of choppy water, as on an ocean.

Choppy — (Oceanography) Describing rough, short, irregular wave motion on the surface of the water.

Chott, also Shott — (1) The depression surrounding a salt marsh or lake, especially in North Africa. (2) The bed of a dried salt marsh.

Chresard — Water present in the soil and available for plant absorption.

Chronic — (1) Showing effects only over a long period of time, as in chronic toxicity. (2) Occurring over a long period of time, either continuously or intermittently; used to describe ongoing exposures and effects that develop only after a long exposure.

Chronic Exposure — Long-term, low-level exposure to a toxic chemical.

Chuckhole — A rough hole in pavement, made by wear and weathering, more commonly referred to as *Pothole*.

Chute — A clear channel between obstructions, steeper and faster than the surrounding water.

Chute, or Chute Cutoff — As applied to stream flow, the term “chute” refers to a new route taken by a stream when its main flow is diverted to the inside of a bend, along a trough between low ridges formed by deposition on the inside of the bend where water velocities were reduced. Compare with *Neck Cutoff*.

Chute Spillway — The overflow structure which allows water to drop rapidly through an open channel without causing erosion. Usually constructed near the edge of dams.

Cienega — A Southwestern United States, non-forested wetland. Cienegas are dominated by *Graminoids* and may be seasonally dry.

Cinder (Volcanic) — Medium-grained rock material derived from volcanic explosions.

Circle of Influence — The circular outer edge of a depression produced in the water table by the pumping of water from a well. Also see *Cone of Influence* and *Cone of Depression*.

Circulate (or Circulation) — Movement or passage through a system of vessels, as water through pipes.

Circulation — (Oceanography) The water current flow within a large area. Also see *Ocean Current*.

Circumneutral — Term applied to water with a pH of 5.5 (acidic) to 7.4 (alkaline).

Cirque — A smallish, rounded depression with steeply sloping sides carved into the rock at the top of a ridge where a glacier has its head. After the period of glaciation ends, the cirque may contain a small remnant of the former glacier, or it may fill with water and become a lake. The term *Tarn* is also used to describe lakes that have formed in cirques.

Cirque Basin — A half-amphitheater formed by alpine *Glaciation (Cirque Glacier)* with three steep sides. Usually found at upper ends of valleys and along ridges.

Cirque Glacier — A small mountain glacier that has not yet flowed out of the *Cirque*.

Cirque Lake — A small, deep, clear-water glacial lake fed by runoff from surrounding slopes and retained in a *Cirque*. Also referred to as a *Tarn*.

Cirrocumulus Clouds — A high-altitude cloud composed of a series of small, regularly arranged cloudlets in the form of ripples

or grains. Also see *Cloud*.

Cirrostratus Clouds — A high-altitude, thin hazy cloud, usually covering the sky and often producing a halo effect. Also see *Cloud*.

Cirrus Clouds — A principal cloud type found at high altitudes and composed of ice crystals collected into delicate wisps or patches. Also see *Cloud*.

Cistern — (1) A small tank (usually covered) or a storage facility used to store water for a home or farm. Often used to store rain water. (2) An artificial reservoir or tank used for holding or storing water or other liquids. Typically a tank, often underground, used for storing rain water collected from a roof.

Clam-Flat — (New England) A level stretch of soft tidal mud where clams burrow.

Clammy — (1) Disagreeably moist, sticky, and cold to the touch. (2) Damp and unpleasant.

Clarification — A process or combination of processes where the primary purpose is to reduce the concentration of suspended matter in a liquid.

Clarifier — (1) A large circular or rectangular tank or basin in which water is held for a period of time, during which the heavier suspended solids settle to the bottom. Clarifiers are also called settling basins and sedimentation basins. (2) A device or tank in which wastewater is held to allow the settling of particulate matter.

Clarification — The process of removing suspended or colloidal matter from a turbid liquid.

Clarity — A term describing the clearness of water. The absence of suspended matter which affects transmission of light.

Class (Pipe and Fittings) — The working pressure rating of a specific pipe for use in water distribution systems which includes allowances for surges. This term is used for cast iron, ductile iron, asbestos cement and some plastic pipe.

Class A Pan — The U.S. Weather Bureau evaporation pan is a cylindrical container fabricate of galvanized iron or monel metal with a depth of 10 inches and a diameter of 48 inches. The pan is placed on an open 2- X 4-inch wooden platform with the top of the pan about 41 cm (16 inches) above the soil surface. It is accurately leveled at a site that is nearly flat, well sodded, and free from obstructions. The pan is filled with water to a depth of eight inches, and periodic measurements are made of the changes of the water level with the aid of a hook gage set in the still well. When the water level drops to seven inches, the pan is refilled. Its average pan coefficient is about 0.7 for lake evaporation.

Classes, Injection Wells — Classifications of the U.S. *Environmental Protection Agency (EPA)* that determine the permit requirements of an *Injection Well*. The following classes apply:

- [1] **Class I** — A well into which liquid hazardous wastes or other fluids are pumped down, with the fluids being injected into an underground formation below the lowest underground source of drinking water that is within a one-quarter mile radius of the well;
- [2] **Class II** — A well used to dispose of fluids produced by oil and gas wells, to introduce fluids for enhanced oil recovery, or for liquid hydrocarbon storage;
- [3] **Class III** — A well used to pump fluids underground for mineral extraction;
- [4] **Class IV** — A well used to re-inject treated fluid from a superfund cleanup site into or above an underground formation within a one-quarter mile radius of the well;
- [5] **Class V** — Wells not included in Classes I–IV, mainly shallow industrial disposal wells or *Recharge Wells*.

Classical Inference — (Statistics) Statistical inference is based on two basic premises: (1) The sample data constitute the only relevant information; and (2) The construction and assessment of the different procedures for inference are based on long-run behavior under essentially similar circumstances. Also see *Statistical Inference* and *Bayesian Inference*.

Classical Linear Regression (CLR) Model — (Statistics) The standard for the *Ordinary Least Squares (OLS)*, or *Regression Analysis* model. The CLR Model has five basic assumptions:

- [1] **Linearity** — The dependent variable, or the variable to be explained or forecasted, can be calculated as a linear function of a specific set of independent, or explanatory variables;
- [2] **Randomness of Disturbance Terms** — The expected value of the disturbance term, that is the term showing the differences between the model's estimated values and the actual observed values, is zero;
- [3] **Uncorrelated Disturbance Terms** — The disturbance terms all have the same variance and are not correlated with each other (see *Serial Correlation*);
- [4] **Data Conformity** — The observations on the independent variable can be considered fixed in repeated samples, i.e., it is possible to repeat the sample with the same independent variables;
- [5] **Sample Size and Selection** — The number of observations is greater than the number of independent variables and that there are no linear relationships, i.e., no significant correlations, between the independent variables (see *Multicollinearity*).

Classification (Soils) — The systematic arrangement of soils into groups or categories on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties. *Soil Taxonomy* is the study of soil classification systems. For a description of soil classifications, see *Land Capability Classes*.

Clast (Clastic) — (1) Pertaining to a rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and that have been transported some distance from their places of origin. (2) An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering (disintegration) of a larger rock mass.

Clay — (1) A fine-grained inorganic material, less than 0.0002 inches or less than 0.004 millimeters in diameter, which has very low permeability. (2) A fine-grained, firm earth material that is plastic when wet and hardens when heated, consisting primarily of hydrated silicates of aluminum and widely used in making bricks, tiles, and pottery; one type of soil particle with a diameter of approximately one ten-thousandth of an inch. (3) A hardening or non-hardening material having a consistency similar to clay

and used for modeling. (4) A composition of minerals that are essentially hydrous aluminum silicates. (5) (Geology) A sedimentary material with grains smaller than 0.2 millimeters in diameter. (6) Moist, sticky earth; mud.

Clay Liner — A layer of clay soil that is added to the bottom and sides of a pit designed for use as a disposal site for potentially dangerous wastes. The clay prevents or reduces the migration of liquids from the disposal site.

Clayballs — Both small and fairly large chunks of clay rounded by wave action. These are occasionally observed on Michigan beaches, especially a narrow strand bordered by steep clay banks of hard glacial till. Also known as mud balls, armored mud balls, pudding balls. Balls of a different origin, aggregates from clay in suspension or in a viscous state, are also sometimes formed in the beds of lakes and rivers.

Claybanks (Lakeshore) — Term applied to lake bluffs, or cliffs, composed almost entirely of till clay or glacial lacustrine clay.

Claypan — (1) A stratum or horizon of accumulated stiff, compact, and relatively impervious clay which is not cemented and if immersed in water can be worked to a soft mass. (2) A dense, compact layer in the subsoil having a much higher clay content than the overlying material from which it is separated by a sharply defined boundary. Such layers are formed by the downward movement of clay or by synthesis of clay in place during soil formation. Claypans are usually hard when dry, and plastic and sticky when wet. They usually impede movement of water and air, and the growth of plant roots. (3) (Australian) A shallow depression in which water collects after rain. Also see *Hardpan*.

Clayseal — A barrier constructed of impermeable clay that stops the flow of water or gas.

Clay Soil — (1) A soil composed of microscopically small mineral particles that are flattened and fit closely together; spaces between particles for air and water are also small. When clay soil gets wet it dries out slowly because the downward movement of water, i.e., drainage, is slow. (2) A soil containing more than 40 percent clay, but less than 45 percent sand, and less than 40 percent silt.

Clean (Water) — Water that is free from foreign matter or pollution; not infected; unadulterated.

Clean Water Act (CWA) [Public Law 92–500] — (1) A law enacted by the U.S. Congress in 1972 and enforced by the *U.S. Environmental Protection Agency (EPA)* nationally and state and local government environmental agencies. The Clean Water Act established three main goals: (a) “zero discharge” or the elimination of polluting discharges to the nation’s waters by 1985; (b) “fishable and swimmable waters” or the restoration and protection of water quality and wildlife habitat; and (c) “no toxics in toxic amounts” or the prohibition of the discharge of toxic pollutants in amounts that are toxic to the environment or life. (2) More formally referred to as the *Federal Water Pollution Control Act*, the Clean Water Act constitutes the basic federal water pollution control statute for the United States. Originally based on the *Water Quality Act* of 1965 which began setting water quality standards. The 1966 amendments to this act increased federal government funding for sewage treatment plants. Additional 1972 amendments established a goal of zero toxic discharges and “fishable” and “swimmable” surface waters. Specifically, the purpose of the CWA of 1972 was to “restore and maintain the chemical, physical, and biological integrity of the nation’s waters.” The act’s three primary goals included: (a) all of the nation’s waters should be fishable and swimmable by 1983; (b) all polluting discharges should be eliminated by 1985; and (c) no toxic pollutants in toxic amounts should be discharged. The primary regulatory tool created by the act was the *National Pollutant Discharge Elimination System (NPDES)*, a permitting process intended to first reduce and eventually eliminate all discharges. Enforceable provisions of the CWA include technology-based effluent standards for point sources of pollution, a state-run control program for nonpoint pollution sources, a construction grants program to build or upgrade municipal sewage treatment plants, a regulatory system for spills of oil and other hazardous wastes, and a *Wetlands* preservation program (Section 404). It was amended in 1977 (the Clean Water Act, Public Law 95–217) and again in 1987 (the Water Quality Act, Public Law 100–4).

Clean Water Act (CWA) Section 208 [EPA] — A requirement of the CWA that required states to develop watershed-based plans for controlling *Nonpoint Source (NPS)* pollution, and the federal law gave the *U.S. Environmental Protection Agency (EPA)* the authority to set up plans for controlling polluted runoff.

Clean Water Act (CWA) Section 301(h) [EPA] — Section 301(h) was added to the *Clean Water Act* in 1977 allowing for a case-by-case review of treatment requirements for marine dischargers that applied by September 13, 1979. Eligible *Publicly Owned Treatment Works (POTWs)* applicants that discharged into marine waters and met the set of environmentally stringent criteria in section 301(h) would receive a modified *National Pollutant Discharge Elimination System (NPDES)* permit waiving the secondary treatment requirements for the conventional pollutants *Biochemical Oxygen Demand (BOD)*, *Suspended Solids (SS)*, and *pH*. The *U.S. Environmental Protection Agency (EPA)* issued regulations and a technical support document for the 301(h) program in 1979. In support of this section, POTWs that discharged into marine waters had argued that the discharge requirements established in 1972 by the Federal Water Pollution Control Act Amendments might be unnecessary on the grounds that marine POTWs, as opposed to stream and river dischargers, usually discharge into deeper waters with large tides and substantial currents, which allow for greater dilution and dispersion than their freshwater counterparts.

Clean Water Act (CWA) Section 303 [EPA] — Section 303 of the Water Quality Act of 1987 added a number of new requirements and prohibitions to the *Clean Water Act (CWA)* Section 301(h) program. All *Publicly Owned Treatment Works (POTWs)* applying for a 301(h) modified permit must achieve primary or equivalent treatment to remove at least 30 percent of conventional pollutants and must meet water quality criteria. Further, those POTWs serving a population of more than 50,000 with industrial sources of toxic pollutants must implement an urban area pretreatment program. Also, POTWs discharging to stressed estuaries are not eligible for a 301(h) waiver. A POTW applying for a 301(h) waiver must meet the criteria established in the Clean Water Act, including:

- Existence of and compliance with water quality standards;
- Protection and propagation of a balanced indigenous population of fish, shellfish, and wildlife;
- Allowance of recreational activities;
- Establishment of a monitoring program;

- Satisfactory toxics control programs, including an approved pretreatment program;
- No additional treatment requirements for other sources as a result of the waiver;
- No increase in effluent volume or amount of pollutants discharged above limits in 301(h) modified permit; and
- Protection of public water supplies.

A POTW receiving a 301(h) modified permit is required to monitor the impact of its discharge on the water quality and marine biota. The *U.S. Environmental Protection Agency (EPA)* uses the POTWs monitoring results to evaluate applications for permit renewal and compliance with *National Pollutant Discharge Elimination System (NPDES)* permit terms and conditions.

Clean Water Act (CWA) Section 303(d) [EPA]— Section 303(d) of the CWA established the nation's *Total Maximum Daily Loads (TMDL)* Program. Despite national standards and required pollution controls, many of our waterways still do not meet the CWA goal of being “fishable and swimmable.” The mission of the TMDL Program is to work towards healthy watersheds by assisting states, territories, and tribes to meet their water quality standards. Under the program, states identify impaired waterbodies, or those not meeting standards, and develop TMDLs for these waters. A TMDL specifies the amount by which a specific pollutant must be reduced to meet water quality standards and allocates pollution control responsibilities among the sources of pollution in the watershed. The *U.S. Environmental Protection Agency (EPA)* reviews and approves the lists of impaired waters and the TMDLs developed for them, and will develop the TMDLs if the state or territory does not. TMDLs are a critical analytic underpinning for watershed decisions and can serve to integrate solutions to water quality problems from point and nonpoint sources and to protect drinking water sources, wetlands, and endangered species.

Clean Water Act (CWA) Section 305(b) [EPA] — Section 305(b) of the Clean Water Act directs each state to prepare a biennial report to be submitted to the *U.S. Environmental Protection Agency (EPA)* describing the quality of its waters. These reports identify which waters within the state support designated uses and which are impaired. For impaired waters the states are also required to describe the type and source of pollutants. The *Office of Wetlands, Oceans, and Watersheds (OWOW)* then compiles these state assessments to prepare a national water quality inventory report for the Congress. The report focuses on the extent to which water quality meets goals and standards established to protect aquatic ecosystems, drinking water supplies, fish consumption, recreational activities and other uses designated by states. In addition, the Clean Water Act directs the states to report on their progress in controlling water pollution, including the costs and benefits of achieving designated use support.

Clean Water Act (CWA) Section 312 [EPA] — The discharge of untreated or partially treated human wastes from vessels can contribute to high bacteria counts and subsequent increased human health risks, and these problems can be particularly detrimental biota in lakes, slow moving rivers, marinas and other bodies of water with low flushing rates. When concentrations of fecal coliform bacteria rise above safe levels, local health boards act to close swimming areas. A fecal coliform bacteria count of 14 (or greater) most probable number (MPN) per 100 milliliters of water results in the closing of shellfish beds. The *U.S. Environmental Protection Agency (EPA)*, the Coast Guard, and individual states work together, under *Clean Water Act (CWA)* Section 312, to protect human health and the aquatic environment from disease-causing microorganisms which may be present in sewage from boats. Section 312 provides States with a tool to protect their citizens and aquatic habitats through standards for *Marine Sanitation Devices (MSD)* – boat toilets or heads – and *No-Discharge Zone (NDZ)* designations for vessels. Under Section 312 a state can have all or portions of their waters designated as a no-discharge zone for vessel sewage to achieve any of the following objectives: (a) to protect aquatic habitats where pumpout facilities are available; (b) to protect special aquatic habitats or species [the state does not have to show that there are reasonably available pump-out or dump stations]; and (c) to safeguard human health by protecting drinking water intake zones [the state does not have to show that there are reasonably available pump-out or dump stations].

Clean Water Act (CWA), Section 319 [EPA] — Section 319 of the Clean Water Act establishes the Nonpoint Source Management Program. Many water quality problems today are caused by diffuse, or nonpoint source pollution. This polluted runoff is largely responsible for nearly 40 percent of the nation's assessed waterbodies not meeting the uses for which they have been designated by the states, i.e., fishing, swimming, or as a drinking water supply. The CWA provides for the control of nonpoint source pollution through Section 319 to encourage greater state, tribal, and federal leadership to address this significant source of water quality degradation. Under Section 319, states, territories, and tribes develop and implement their own nonpoint source management programs tailored to their key nonpoint source pollution problems. The *U.S. Environmental Protection Agency (EPA)* provides grants to help them administer their nonpoint source programs as well as guidance for improving best management practices to control runoff. In addition, under Section 6217 of the *Coastal Zone Management Act (CZMA)* Amendments of 1990, EPA's *Office of Wetlands, Oceans, and Watersheds (OWOW)* provides guidance to states regarding the effective control of nonpoint source pollution in coastal areas, and with *National Oceanic and Atmospheric Administration (NOAA)* jointly works with coastal states to develop and implement coastal nonpoint source programs.

Clean Water Act (CWA), Section 402 [EPA] — A 1987 amendment to the CWA which reclassified as point sources the runoff from cities of 100,000 persons or more. The *U.S. Environmental Protection Agency (EPA)* required states to issue *National Pollutant Discharge Elimination System (NPDES)* “storm water” permits, which for the most part rely on *Best Management Practices (BMPs)* to reduce pollution rather than the strict effluent limits used in previous NPDES permits.

Clean Water Act (CWA) Section 403 [EPA] — Under the Clean Water Act, point source discharges (i.e., discharges from municipal and industrial facilities) to waters of the United States must obtain a *National Pollutant Discharge Elimination System (NPDES)* permit, which requires compliance with technology-based and water quality-based treatment standards. In addition, because of the complexity and ecological significance of marine ecosystems, discharges to the territorial seas and beyond must also comply with section 403 of the CWA, which specifically addresses impacts from such point sources on marine resources. The section 403 program was one of the first of *U.S. Environmental Protection Agency's (EPA)* programs to incorporate *Ecological Risk Assessment* as part of the evaluation of the impacts of point source discharges on the marine environment. The section 403 requirements are intended to ensure that no unreasonable degradation of the marine environment will occur as a result

of the discharge and to ensure that sensitive ecological communities are protected. These requirements can include ambient monitoring programs designed to determine degradation of marine waters, alternative assessments designed to further evaluate the consequences of various disposal options, and pollution prevention techniques designed to further reduce the quantities of pollutants requiring disposal and thereby reduce the potential for harm to the marine environment. If section 403 requirements for protection of the ecological health of marine waters are not met, an NPDES permit will not be issued. To implement section 403, EPA developed the *Ocean Discharge Guidelines*.

Clean Water Act (CWA), Section 404 [EPA/Corps] — Section 404 of the CWA establishes a permit program to regulate discharges of dredged or fill material into waters, including wetlands, of the United States. Section 404 outlines specific and coordinated responsibilities for both the *U.S. Environmental Protection Agency (EPA)* and the *U.S. Army Corps of Engineers (Corps)*. EPA is required, in conjunction with the Corps, to establish environmental standards for reviewing Section 404 permit applications for activities that would fill wetlands for residential development, roads, levees, and other projects. The Corps is charged with administering the Section 404 permit program, processing applications in accordance with EPA's standards, and issuing permits, where appropriate, after notice and an opportunity for public comment. Both EPA and the Corps have enforcement responsibility and routinely coordinate the review of Section 404 permit applications to ensure that permit decisions are made in a timely manner, while providing effective protection for human health and environmental quality. States can assume the 404 program for some waters and, as of 1999, New Jersey and Michigan had done so. Many states administer other programs to protect wetlands, some of which are recognized through Clean Water Act general permits. See *Wetland Mitigation*.

Clean Water Standards (EPA) — Generally refers to any enforceable limitation, control, condition, prohibition, standard, or other requirement which is promulgated pursuant to the *Federal Water Pollution Control Act (Clean Water Act)* [Public Law 92–500] or contained in a permit issued to a discharger by the *U.S. Environmental Protection Agency (EPA)* or by a state under an approved program, as authorized by Section 402 of the Clean Water Act, or by local governments to ensure compliance with pretreatment regulations as required by Section 307 of the Clean Water Act.

Cleanup [EPA] — The term “cleanup” or the phrase “cleaning up” refers to the range of activities that could occur in the context of addressing environmental contamination at *U.S. Environmental Protection Agency (EPA)* designated *Resource Conservation and Recovery Act (RCRA)* facilities. For example, cleanup activities could include removing waste or contaminated media (e.g., excavation and pumping groundwater), in-place treatment of the waste or contaminated media (e.g., *Bioremediation*), containment of the waste or contaminated media (e.g., barrier walls, low-permeable covers, and liners), or various combinations of these approaches. The term cleanup is often used interchangeably with the term *Remediate*.

Cleanup Timeframes [EPA] — The cleanup timeframe, with respect to groundwater, is an estimate of when groundwater quality will achieve a certain level at a specified location and/or the schedule developed to take an action or construct a remedy designed to achieve a particular short-term protection, intermediate performance, or final cleanup goal.

Clear Ice — A term for relatively transparent ice having a homogeneous structure and few air pockets.

Clear Well — (1) A reservoir containing potable water which has been previously treated before entering the distribution lines. (2) A reservoir for the storage of filtered water of sufficient capacity to prevent the need to vary the filtration rate with variations in demand. Also used to provide chlorine contact time for disinfection.

Cleavage — The capacity of a mineral to break along plane surfaces as determined by the crystal structure.

Clepsydra — An ancient device that measured time by marking the regulated flow of water through a small opening. Also referred to as a *Water Clock* or *Water Glass*.

Cliff (Lakeshore) — Often used interchangeably with bank and bluff, in technical descriptions the term cliff is preferred for the wave-cut nearly vertical acclivity or abrupt slope which borders the waterline, or marks the position of the present or former shore lines of lakes.

Climate — (1) The composite or generally prevailing weather conditions of a region, as temperature, air pressure, humidity, precipitation, sunshine, cloud cover, winds, etc. (2) The sum total of the meteorological elements that characterize the average and extreme conditions of the atmosphere over a long period of time at any one place or region of the earth's surface. The collective state of the atmosphere at a given place or over a given area within a specified period of time. Compare to *Weather*. Basic types of climates include:

- [1] **Continental** — The climate characteristic of land areas separated from the moderating influences of oceans by distance, direction, or mountain barriers and marked by relatively large daily and seasonal fluctuations in temperature;
- [2] **Oceanic** — The climate characteristic of land areas near oceans which contribute to the humidity and at the same time have a moderating influence on temperature and the range of temperature variation.

Climatic Amelioration — The altering of a prevailing weather condition.

Climatic Cycle — The periodic changes of climate, including a series of dry years following a series of years with heavy rainfall.

Climatic Year — A period used in meteorological measurements. A continuous 12-month period during which a complete annual cycle occurs, arbitrarily selected for the presentation of data relative to hydrologic or meteorologic phenomena. The hydrologic climatic year in the United States begins on October 1st and runs through September 30th. For precipitation measures, the climatic year begins on July 1 and ends the following June 30, and are designated by the calendar year in which the water year ends. Similar to a *Water Year*.

Climatology, also Climatological — The science and study dealing with climate, climatic conditions, and climatic phenomena as exhibited by temperature, winds, and precipitation.

Climax — (1) The final stage of vegetation succession; a climax community reproduces itself and is in equilibrium with the existing environment. (2) The state of a *Biotic Community* attained when constituent species populations fluctuate rather than exhibit

successional replacement and thereby self-perpetuate as long as climatic, edaphic (soil), and biotic conditions continue.

Clod — A compact, coherent mass of soil ranging in size from 5 to 10 millimeters (0.20 to 0.39 inch) to as much as 200 to 250 millimeters (7.87 to 9.84 inches) produced artificially, usually by the activity of man by plowing, digging, etc., especially when these operations are performed on soils that are either too wet or too dry for normal tillage operations.

Clog Snow — A popular term for new snow that is wet and sticky.

Closed Basin — (1) A groundwater basin whose topography and geology prevent subsurface outflow of water. (2) A hydrographic basin (basin, area or sub-area) is considered closed with respect to surface water flow if its topography prevents the occurrence of visible surface water outflow. It is closed hydrologically if neither surface nor underground water outflow can occur.

Closed-Basin Lake — A lake which has no outlet, from which water escapes only by evaporation.

Closed Canopy — Forest trees dense enough that tree crowns fill or nearly fill the canopy layer.

Closed Conduit System — A conveyance system where the flow of water is confined on all boundaries (i.e., pipe systems).

Closed-Cycle Cooling — A process in which cooling water used in industrial processes or in the generation of electrical energy is not discharged into receiving streams, where direct discharge can have adverse effects, but is circulated through cooling towers, evaporators, ponds, or canals to allow the dissipation of the heat, and the water to be reused.

Closed Drain — Subsurface drain, tile, or perforated pipe that receives surface water through surface inlets.

Closed Drainage — Surface drainage that does not reach the ocean, but collects in a sink, lake, or interior basin. Also see *Internal Drainage* and *Interior Drainage*.

Closed Lake — A lake having no surface outlet, so that it loses water only through evaporation or seepage and is saline or brackish. Also see *Terminus Lake*.

Closed-Loop Recycling — Recycling or reusing wastewater for non-potable purposes in an enclosed process.

Closed Sea — (Oceanography) (1) The opposite of open sea; a part of the ocean enclosed by headlands or within narrow straits. (2) A part of the ocean inside the territorial limits of a country.

Closed Water Loop — A process in which decontaminated wastewater is not discharged into a receiving stream but is reused. Any water lost during the process through evaporation or binding with some material is replaced by makeup water. Contrast with *Open Water Loop*.

Closet — A water closet; a toilet.

Cloud — A cloud is any concentration of gas, liquid droplets, or solid particles suspended as a distinct body in a gas or liquid.

Generally, however, the term cloud is used to refer to the suspension of small ice or water particles in the *Atmosphere*. **Cloud Formation** — Clouds in the atmosphere form whenever the relative *Humidity* of an air mass, or parcel, reaches slightly more than 100 percent. This can occur for a number of reasons: the upward motion of air, which causes expansion and cooling; input of water from outside the parcel; or loss of heat by radiation. Among the major producers of the upward motion that results in clouds are the *Low-Pressure* systems with their cold, warm, and occluded *Fronts*; tropical disturbances such as *Hurricanes*, *Cyclones*, or *Typhoons*; and the lifting of air as it flows over hilly and mountainous terrain. The size of cloud droplets and ice crystals ranges from about 1 to 100 micrometers (4/100,000 to 4/1,000 in). Particles this small fall to the ground so slowly that they appear suspended in air, tending to move with the wind. The fall of larger particles, at much greater speeds, is called *Precipitation*. About 1 million cloud droplets, with an average radius of 10 micrometers (4/10,000 inch), are required to make a typical raindrop of 1 mm (4/100 inch). Cloud droplets can exist at temperatures below 0EC (32EF) and are then referred to as supercooled. When supercooled water and ice crystals occur at the same location, the ice grows at the expense of the water, and an ice cloud forms. This occurs because at a given temperature ice has a greater affinity than liquid water for water vapor. Cloud droplets and ice crystals first form on certain types of small particles of dust or other airborne materials. They are called condensation nuclei when water droplets are formed and ice nuclei when ice crystals result. The nuclei generally range in size from as small as 0.01 micrometer to about 1 micrometer (4/10,000,000 to 4/100,000 inch). The number of nuclei vary widely, depending on the source of the air mass in which the parcel is imbedded. The atmosphere over the ocean generally has the lowest number of nuclei, whereas polluted air has the highest. The more nuclei, and therefore the more water droplets or ice crystals, the slower the process of formation of precipitation-sized particles, because the competition for the available water is greater. Thus, although *Rain* often falls shortly after a cloud forms over the ocean, a much longer time is required over continental areas.

Cloud Classification — Clouds are classed as warm if their temperature throughout is above 0EC (32EF) and cold if they extend to heights where temperatures are less than 0E C. Cold clouds containing both supercooled water and ice are defined as mixed clouds; clouds composed entirely of ice are said to be glaciated. Some cold clouds contain only supercooled water. These clouds are hazardous to aviation because the water, freezing on impact with an airplane, can cause ice to build up on the fuselage and wings. Clouds, defined in terms of their gross physical characteristics, can be classified as *Stratiform* or *Cumuliform*. Stratiform, or layered, clouds form when the upward motion is relatively uniform over an area, and cumuliform, or cottony, billowing clouds develop when upward and downward air currents are separated by fairly short distances. When clouds form at ground surface they are called *Fog*. Clouds that form in the middle *Troposphere* are called *Altostratus* and *Alto cumulus*, and those in the upper troposphere are referred to as *Cirrocumulus*, *Cirrostratus*, or *Cirrus*. For those with bases in the lower troposphere, the terms *Stratus* and *Cumulus* are used. When precipitation is falling from these clouds, they are referred to with such terms as *Nimbostratus* or *Cumulonimbus*. Nimbostratus are the gray, leaden-sky clouds often produced by large-scale winter *Cyclones* in which precipitation is fairly steady and long-lasting. Cumulonimbus clouds, on the other hand, are associated with typical summertime *Thunderstorms*, in which rainfall is generally brief but heavy. A system of classifying clouds according to their physical characteristics has been devised by the *World Meteorological Organization*. Some of the more common cloud types are listed below:

- [1] **Cirrus** — A high-altitude cloud composed of narrow bands or patches of thin, generally white, fleecy parts, typically at an average height of 7 miles (11.3 kilometers);

- [2] **Cirrocumulus** – A high-altitude cloud composed of a series of small, regularly arranged cloudlets in the form of ripples or grains, typically at an average height of 5 miles (8 kilometers);
- [3] **Cirrostratus** – A high-altitude, thin hazy cloud, usually covering the sky and often producing a halo effect, typically at an average height of 6 miles (9.7 kilometers);
- [4] **Altostratus** – A somewhat high level, blue to grayish blue cloud that forms a sheet or layer, typically at an average height of 3.5 miles (5.6 kilometers);
- [5] **Alto cumulus** – A fleecy cloud, usually a rounded mass, but which can change radically and unexpectedly, producing intermediate forms, typically at an average height of 2.5 miles (4 kilometers);
- [6] **Cumulonimbus** – An extremely dense, vertically developed cumulus with a relatively hazy outline and a glaciated top extending to great heights, usually producing heavy rains, thunderstorms, or hailstorms, typically at an average height of 4 miles (6.4 kilometers);
- [7] **Cumulus** – A dense, white, fluffy, flat-based cloud with a multiple rounded top and a well-defined outline, usually formed by the ascent of thermally unstable air masses, typically at an average height of 2 miles (3.2 kilometers);
- [8] **Nimbus/Nimbostratus** – A rain cloud, especially a low dark layer of clouds precipitating continuous rain or snow, typically at an average height of .25 mile (.4 kilometer);
- [9] **Stratus** – A low-altitude cloud formation consisting of a horizontal layer of gray clouds, typically at an average height of .25 mile (.4 kilometer);
- [10] **Stratocumulus** – A low-lying cloud formation occurring in extensive horizontal layers with rounded summits, typically at an average height of 1 mile (1.6 kilometers).

Cloud Chamber — A vessel containing air saturated with water vapor whose sudden expansion reveals the passage of an ionizing particle by a trail of visible droplets.

(Weather Conditions) Cloud Cover [NWS] — Terms used by the *National Weather Service (NWS)* in their forecasts of weather conditions and cloud cover. The following terms are typical:

- [1] **Clear (Sunny)** – A term when used in NWS forecasts denotes 0 to 10 percent coverage of thick (e.g., sun blocking) clouds;
- [2] **Mostly Clear (Mostly Sunny)** – A term when used in forecasts denotes 10 to 30 percent coverage of thick (e.g., sun blocking) clouds;
- [3] **Partly Cloudy (Partly Sunny)** – A term when used in forecasts denotes 30 to 60 percent coverage of thick (e.g., sun blocking) clouds;
- [4] **Mostly Cloudy (Considerable Cloudiness)** – A term when used in forecasts denotes 70 to 80 percent coverage of thick (e.g., sun blocking) clouds; and
- [5] **Cloudy** – A term when used in forecasts denotes 90 to 100 percent coverage of thick (e.g., sun blocking) clouds.

Cloud Modification — Any process by which the natural course of development of a cloud is altered by artificial means. Also referred to as *Weather Modification*.

Cloud Seeding — A *Weather Modification* technique involving the injection of a substance into a cloud for the purpose of influencing the cloud's subsequent development. Ordinarily, this refers to the injection of a nucleating agent, which creates a nucleus around which precipitation will form. In common practice, cloud seeding involves the aerial release of silver iodide particles into convective clouds to create thunderstorms.

CMP — Comprehensive Monitoring Plan.

Cloud Streets — Rows of cumulus or cumulus-type clouds aligned parallel to the low-level wind.

Cloudburst — A sudden and extremely heavy downpour of rain that is small in areal extent, of short duration, and may be accompanied by lightning, thunder, and strong gusts of winds. Also, a torrential (hard) downpour of rain, which by its spottiness and relatively high intensity suggests the bursting and discharge of water from a cloud all at once.

Coagulant — (1) An agent that causes a liquid or sol to coagulate. (2) (Wastewater Treatment) A chemical compound, such as *Alum* (aluminum sulfate), used to produce coagulation.

Coagulant Aid — (1) Any chemical or substance used to assist or modify coagulation. (Wastewater Treatment) (2) Fine particles with high surface area and high specific gravity providing for increased particle collisions during the neutralization process in wastewater treatment plants. They also improve settling and strengthen flocs in the coagulation process. They are generally used in much smaller doses than the coagulant itself. For example, *Sodium Bicarbonate* increases the efficiency of coagulation and extends the pH range to a level at which *Alum* (aluminum sulfate), is effective.

Coagulants — Chemicals that cause very fine particles to clump together into larger particles. This makes it easier to separate the solids from the water by settling, skimming, draining or filtering.

Coagulate — To cause the transformation of a liquid or sol, for example, into or as if into a soft, semisolid, or solid mass.

Coagulation — (1) The clumping of particles which results in the settling of impurities. It may be induced by coagulants such as lime, alum, and iron salts. (2) The clumping together of very fine particles into larger particles caused by the use of chemicals (coagulants). The chemicals neutralize the electrical charges of the fine particles and cause destabilization of the particles. This clumping together makes it easier to separate the solids from the water by settling, skimming, draining, or filtering.

Coal Slurry Pipeline — A pipeline which transports pulverized coal suspended in liquid, usually water.

Coalescence — The merging of two water drops as a result of collision.

Coastal Barrier — A naturally occurring island, sandbar, or other strip of land, including coastal mainland, that protects the coast from severe wave wash.

Coastal Barrier Resources System (CBRS) — Undeveloped communities, coastal barriers, and other protected areas designated

as subject to certain flood insurance coverage restrictions. These areas were identified by the Coastal Barrier Resources Act of 1982 (CBRA) and the Coastal Barrier Improvement Act of 1990 and are shown on appropriate *Flood Insurance Rate Map (FIRM)* panels.

Coastal Current — (Oceanography) A current running parallel to the shore and just beyond the surf zone.

Coastal High Hazard Area — (FEMA) Area of special flood hazard – designated Zone V, VE, or V1-V30 on a *Flood Insurance Rate Map (FIRM)* – that extends from offshore to the inland limit of a primary frontal dune along an open coast, and any other area subject to high-velocity wave action from storms or seismic sources.

Coastal Nonpoint Source Pollution Control Program [EPA and NOAA] — Section 6217 of the *Coastal Zone Act Reauthorization Amendments (CZARA)* of 1990 was intended to address nonpoint pollution problems in coastal waters. The CZARA recognized that a significant portion of the threats to coastal waters are caused by *Nonpoint Source Pollution (NPS)*. Major sources of such pollution in coastal waters include agriculture and urban runoff. Other significant sources include faulty septic systems, forestry activities, marinas and recreational boating, physical changes to stream channels, and habitat degradation, especially the destruction of wetlands and vegetated areas near streams. Section 6217 requires the 29 states and territories with approved Coastal Zone Management Programs to develop Coastal Nonpoint Pollution Control Programs. In its program, a state or territory describes how it will implement nonpoint source pollution controls, known as management measures, that conform with those described in *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. This program is administered jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA). The coastal nonpoint program strengthens the links between federal and state/territory coastal zone management and water quality programs in order to enhance efforts to manage land management activities that degrade coastal waters and coastal habitats. State and territorial coastal zone agencies and water quality agencies have coequal roles, as do NOAA and EPA at the federal level. Approved programs include several key elements, described below:

- [1] **Boundary** – The boundary defines the region where land and water uses have a significant impact on a states or territory's coastal waters. It also includes areas where future land uses reasonably can be expected to impair coastal waters. To define the boundary, a state or territory may choose a region suggested by NOAA or may propose its own boundary based on geologic, hydrologic, and other scientific data.
- [2] **Management Measures** – The state or territory coastal nonpoint program describes how a state or territory plans to control NPS pollution within the boundary. To help states and territories identify appropriate technologies and tools, EPA issued *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. This technical guidance describes the best available, economically achievable approaches used to control NPS pollution from the major categories of land management activities that can degrade coastal water quality.
- [3] **Enforceable Policies and Mechanisms** – States and territories need to ensure the implementation of the management measures. Mechanisms may include, for example, permit programs, zoning, “bad actor” laws, enforceable water quality standards, and general environmental laws and prohibitions. States and territories may also use voluntary approaches like economic incentives if they are supported by appropriate regulations.

Coastal State [United States, 50 CFR 85.11] — A “coastal state” is defined as a state of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes. The term also includes Puerto Rico, the Virgin Islands, Guam, and the Commonwealth of the Northern Mariana Islands. The term excludes Alaska and American Samoa because these states have a ratio of the number of recreational vessels in the state numbered under chapter 123 of title 46, United States Code, to number of miles of shoreline (as that term is defined in Sec. 926.2(d) of title 15, Code of Federal Regulations, as in effect on January 1, 1991), of less than one.

Coastal Waters [United States, 50 CFR 85.11] — In the Great Lakes area, the term “coastal waters” includes those waters within the territorial jurisdiction of the United States consisting of the Great lakes, their connecting waters, harbors, roadsteads, and estuary-type areas such as bays, shallows, and marshes. In other areas, coastal waters include those waters, adjacent to the shorelines, which contain a measurable percentage of sea water, including sounds, bays, lagoons, bayous, ponds, and estuaries.

Coastal Wetlands — One of two types of wetlands (the other being *Inland Wetlands*), coastal wetlands are found along the Atlantic, Pacific, Alaskan, and Gulf of Mexico coasts. They are closely linked to the estuaries of the United States, where sea water mixes with fresh water to form an environment of varying salinities. The salt water and the fluctuating water levels (due to tidal influences) combine to create a rather difficult environment for most plants. Consequently, many shallow coastal areas are unvegetated mud flats or sand flats. Some plants, however, have successfully adapted to this environment. Certain grasses and grasslike plants that adapt to the saline conditions form the tidal salt marshes that are found along the Atlantic, Gulf, and Pacific coasts. Mangrove swamps, with salt-loving shrubs or trees, are common in tropical climates, such as in southern Florida and Puerto Rico. Some tidal freshwater wetlands form beyond the upper edges of tidal salt marshes where the influence of salt water ends. Also see *Tidal Fringe Wetlands*.

Coastal Zone — Coastal waters and adjacent lands that exert a measurable influence on the uses of the seas and their resources and biota.

Coastal Zone [United States, 50 CFR 85.11] — The term “coastal zone” has the same meaning that the term has in section 304(1) of the Coastal Zone Management Act of 1992 (16 U.S.C. 1453(1)). The coastal zone consists of coastal waters (including the lands therein and thereunder) and the adjacent shorelands, including islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in Great Lakes waters, to the international boundary between the United States and Canada and, in other areas, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands and protect coastal waters.

Coastal Zone Act Reauthorization — A 1990 act by Congress in which it declared that runoff is “a significant factor in coastal water degradation,” and that “there is a clear link between coastal water quality and land use activities along the shore.” The

amendments required coastal states to develop plans to control *Nonpoint Source (NPS)* pollution to restore and protect coastal waters. The law also requires states to identify land uses that may contribute to the degradation of coastal waters and implement enforceable measures when necessary to achieve water quality standards.

Coastal Zone Management Act (CZMA) — A 1972 federal law, amended in 1980, that provides guidance and financial assistance to voluntary state and local coastal management programs. Goals of the program include the protection of natural resources and the management of land development in coastal areas, along shorelines, and on shorelands (extending inland as far as a strong influence on the shore is expected). The state programs established under the CZMA vary widely in their approach and application.

Coastal Zone Management Program (CZMP) [NOAA] — The Coastal Zone Management Program is a unique federal-state partnership for protecting, restoring, and responsibly developing the nation's important and diverse coastal communities and resources. This is the mission of the National CZMP and its 33 state and territory-based Coastal Management Programs. Through the *National Oceanic and Atmospheric Administration's (NOAA)* responsibilities under the *Coastal Zone Management Act (CZMA)*, the *Office of Ocean and Coastal Resource Management (OCRM)* works with the coastal and Great Lakes states and U.S. island territories to develop and implement these Coastal Management Programs. Under these programs, states and territories agree to work toward balancing the conservation and development of coastal resources using state and territorial management authorities, thereby providing for the sustainable development of the nation's coasts.

Cobble — Rock fragments 7.6 cm (3 inches) to 25.4 cm (10 inches) in diameter.

COD — See *Chemical Oxygen Demand* and *Cone of Depression*.

Code of Federal Regulations (CFR) — (1) The annual compilation of all current regulations that have been issued in final form by any federal regulatory agency. (2) The codification of the general and permanent rules initially published in the Federal Register by the executive departments and agencies of the federal government. The publication is organized by subject titles. Environmental regulations are covered under Title 40, Protection of the Environment.

Co-Dominant — Two or more plant species providing about equal areal cover which in combination control the environment.

Coefficient Term — (Statistics) The weight applied to one of the *Independent (or Exogenous) Variables* in the best prediction of the *Dependent (or Endogenous) Variable*. It is interpreted as the slope of the relation between the independent variable and the dependent variable, or the change in the dependent variable for a unit change in the independent variable.

Coefficient of Determination (R^2) — (Statistics) A common measure of the "Goodness of Fit" in *Regression Analysis* used to assess the degree of causation between two variables or between one or more independent variables and a single dependent variable. The coefficient of determination is equivalent to the square of the *Correlation Coefficient (R)* and reflects the percent of variation in the dependent (explained) variable that is explained by the variations in the independent (explanatory) variable(s). Unlike the correlation coefficient, the coefficient of determination does make an inference of causation, i.e., the changes in one variable do affect changes in another. The value of the coefficient of determination varies between 0 (0 percent) and 1 (100 percent) with higher numbers representing better explanatory powers of a model in explaining the trends in historical data.

Coefficient of Discharge — The ratio of the observed to theoretical discharge.

Coefficient of Linear Extensibility — The ratio of the difference between the moist and dry lengths of a *Clod* to its dry length. The measurement correlates with the volume change of a soil upon wetting and drying.

Coefficient of Mechanical Diffusion — The rate at which solutes are mechanically mixed during *Advective Transport*, caused by the velocity variations at the microscopic level.

Coefficient of Molecular Diffusion — (1) The rate at which solutes are transported at the microscopic level due to variations in the solute concentrations within the fluid phases. (2) The rate of dispersion of a chemical caused by the kinetic activity of the ionic or molecular constituents. Also referred to as the *Diffusion Coefficient*. See *Molecular Diffusion*.

Coefficient of Permeability — An obsolete term that has been replaced by the term *Hydraulic Conductivity*.

Coefficient of Roughness — Factor in fluid flow determination expressing the character of a surface and its fractional resistance to flow. Also see *Roughness Coefficient*.

Coefficient of Runoff — Factor in the rational runoff formula expressing the ratio of peak runoff rate to rainfall intensity.

Coefficient of Storage — The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Coefficient of Transmissivity (t) — The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit *Hydraulic Gradient*. It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the flow paths. Also, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivity values are given in gallons per minute through a vertical section of an aquifer 1 foot wide and extending the full saturated height of an aquifer under a hydraulic gradient of one in the *English Engineering System*; in the *Standard International System*, transmissivity is given in cubic meters per day through a vertical section of an aquifer 1 meter wide and extending the full saturated height of an aquifer under hydraulic gradient of one. It is a function of properties of the liquid, the porous media, and the thickness of the porous media. Also see *Transmissivity*.

Coefficient of Variation (or Statistical Variability) — (Statistics and Data Analysis) (1) A relative measure of dispersion found by expressing the *Standard Deviation* as a percentage of the arithmetic mean. (2) Standard deviation (from the mean) expressed as a percentage of the mean.

Coefficient of Viscosity — The degree to which a fluid resists flow under an applied force, measured by the tangential friction force per unit area divided by the velocity gradient under conditions of streamline flow.

Cofferdam — A temporary watertight enclosure that is pumped dry to expose the bottom of a body of water so that construction, as of piers, a dam, and bridge footings, may be undertaken. Also, a watertight chamber attached to the side of a ship to facilitate repairs below the water line. A *Diversion Cofferdam* prevents all downstream flow by diverting the flow of a river into a pipe,

channel, or tunnel. Also see *Dam*, *Caisson* and *Camel*.

Cogeneration — The process by which energy is extracted from the waste head of an industrial process, such as from a steam boiler or food processing system.

Cohesion — (1) Molecular attraction which holds two particles together. (2) A molecular attraction by which the particles of a body are united throughout the mass whether like of unlike. Compare to *Adhesion*.

Cold Front — The interface between an advancing mass of air that is colder than the one it is replacing, usually at the point of contact with the ground surface.

Cold Vapor — A method to test water for the presence of mercury.

Cold Wall — (Oceanography) A well-defined line where two water masses of different temperatures meet.

Cold-Water — Lacking modern plumbing or heating facilities, as a cold-water residence.

Cold-Water Sphere — (Oceanography) The cold deep-water and bottom-water masses, where the temperature is below 8EC; one of the two major subdivisions of ocean water masses, along with the *Warm-Water Sphere*.

Coldwater Fish — A fish that requires relatively cool water for survival. While the optimum temperature varies by species, most are found in water where temperatures are 20EC (68EF) or less.

Coliform (Bacteria) — (1) A group of bacteria commonly found in the environment. They are an indicator of potential contamination of water. Adequate and appropriate disinfection effectively destroys coliform bacteria. (2) A group of bacteria predominantly inhabiting the intestines of man or animals but also found in soil. While typically harmless themselves, coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms. High coliform levels indicate relatively recent pollution since their survival is short-termed. (3) A group of organisms (*Colon bacilli*) usually found in the colons of animals and humans; non-pathogenic microorganisms used in testing water to indicate the presence of pathogenic bacteria. The presence of coliform bacteria in water is an indicator of possible pollution by fecal material. (4) A group of bacteria found in the intestines of warm blooded animals (including humans) and also in plants, soil, air and water. Fecal coliforms are a specific class of bacteria which only inhabit the intestines of warm blooded animals. The presence of coliform bacteria is an indication that the water is polluted and may contain pathogenic (disease causing) organisms. The presence of coliform group bacteria is an indication of possible pathogenic bacterial contamination. The human intestinal tract is one of the main habitats of coliform bacteria. They may also be found in the intestinal tracts of warm blooded animals, and in plants, soil, air, and the aquatic environment. Fecal coliforms are those coliforms found in the feces of various warm blooded animals; whereas the term “coliform” also includes other environmental sources. Generally reported as colonies per 100 milliliters (ml) of sample.

Coliform Index — An index of the bacteriological quality of water, based on a count of the numbers of coliform bacteria.

Collection Site — A stream, lake, reservoir, or other body of water fed by water drained from a watershed.

Collection System — (Wastewater Treatment) A network of pipes, manholes, cleanouts, traps, siphons, lift stations and other structures used to collect all wastewater and wastewater carried wastes of an area and transport them to a treatment plant or disposal system. The collection system includes land, wastewater lines and appurtenances, pumping stations and general property.

Collector Sewers — (Wastewater Treatment) Pipes used to collect and carry wastewater from individual sources to an interceptor sewer that will carry it to a treatment facility.

Collector System — Conveys water from several individual sources such as groundwater wells and drains and surface inlet drains for rainstorm and snowmelt runoff to a single point of diversion. The collector system is associated with projects that increase water supply and decrease flood damage.

Collector Well — A well located near a surface water supply used to lower the water table and thereby induce infiltration of surface water through the bed of the water body to the well.

Colloidal Suspension — Suspension in water of particles so finely divided that they will not settle under the action of gravity, but will diffuse, even in quiet water, under the random impulses of *Brownian Movement*. Particles typically range in size from about one micron (0.000001 millimeter) to about one millimicron; however, there is no distinct differentiation by particle size between true *Suspension* and colloidal suspension or between colloidal suspension and *Solution*.

Colloids — (1) Very small, finely divided solids (particles that do not dissolve) that remain dispersed in a liquid for a long time due to their small size and electrical charge. When most of the particles in water have a negative electrical charge, they tend to repel each other. This repulsion prevents the particles from clumping together, becoming heavier, and settling out. (2) Any substance with particles in such a fine state of subdivision dispersed in a medium (for example, water) that they do not settle out, but not in so fine a state of subdivision that they can be said to be truly dissolved. (3) Quantities of extremely small particles, typically 0.0001 to 1 micron in size, and small enough to remain suspended in a fluid medium without settling to the bottom. Substances that, when apparently dissolved in water or other liquid, diffuse not at all or very slowly through a membrane and show other special properties, as lack of pronounced effect on the freezing point or vapor pressure of the solvent. Colloids represent intermediate substances between a true dissolved particle and a suspended solid, which will settle out of solution.

Colluvial Hollow — A bow-shaped concavity in bedrock that collects sediment between debris flows.

Colluvial Material — (Geology) Material consisting of *Alluvium* in part and also containing angular fragments of the original rocks. Typically found at the bottom or on the lower slopes of a hill.

Colluvium — (1) A general term used to describe loose and incoherent deposits of rock moved downslope by gravitational force in the form of soil *Creep*, slides, and local wash. (2) A general term applied to any loose, heterogeneous, and incoherent mass of soil material or rock fragments deposited chiefly by gravity-driven mass-wasting usually at the base of a steep slope or cliff, for example, talus, cliff debris, and avalanche material. (3) In valley sediment deposition, colluvium consists of deposits that are derived chiefly from unconcentrated slope wash and soil creep on adjacent valley sides. See *Valley Sediment Deposits*. (4)

Alluvium deposited by unconcentrated surface run-off or sheet erosion, usually at the base of a slope. Also see *Colluvial Material*.

Colon Bacillus — (Microbiology) A rod-shaped bacterium, especially *Escherichia coli* (*E. coli*), a normal, generally nonpathogenic commensal found in all vertebrate intestinal tracts, but which can be virulent, causing diarrhea and other dysenteric symptoms. Its presence in water is an indicator of fecal contamination.

Colonization — (Biology) As applied to vegetation, the invasion of a disturbed area; annual plants are often colonizing species.

Color (Water) — The substances in water that impart a yellowish-brown color to the water. These substances are the result of iron and manganese ions, humus and peat materials, plankton, aquatic weeds, and industrial waste present in the water. Also see *True Color*, and *Water Color* and *Color (of Lake Waters)*.

Color (of Lake Waters) — An effect of light penetration, radiation absorption and reflection. The resultant color is related to: (1) transparency and depth of water; (2) type of lake bottom; and (3) matter held in solution, suspension or floating. Blues and greens are commonly observed in clear water lakes with clean bottoms of sand, rock or marl. Often, the blue tints are in deeper water and greens in shallower sections. Greens are often due to large populations of blue green and green algae in suspension or on the lake bottom. Yellow lake colors may be due to certain species of algae and to diatoms in large populations, and in certain types of lakes yellows have been attributed to sulfur bacteria. Pale yellows, yellow-brown, and coffee color or “black,” can be produced by large quantities of dissolved humic substances and by particulate organic matter in suspension. Reds may be a reflection of the pigment color of certain algae, and may be caused by the presence of certain micro-crustaceans and other zooplankton. The “blood lakes” of central Europe are attributed to the presence of the microorganism *Euglena sanguinea*. Lake waters may be variously colored by suspended particulate inorganic matter especially that which is clayey or colloidal in nature. Some glacial lakes may be milky because of “glacial flour” in suspension, and the shallow water of marl lakes is often milky. Some colors are reflections of yellow sands on shallow bottoms, or from the black of organic sediments, or the blue of the sky. Colors vary with the weather, the time of day and the season. The words white and black have been used to describe lake waters. White has been applied where the water is merely colorless, and sometimes where it is milky from grey or white particulate matter in suspension. Black may be due to large amounts of humic matter in solution, such as that in water flowing from some kinds of bogs, the reflection of black bottoms, or the dull appearance of some waters when the sky is heavily overcast. Unusual colors may also be the result of pollution from industrial wastes.

Colorado River Commission [Nevada] — An agency of the State of Nevada consisting of seven members, to include four members appointed by the Governor and three members from the *Southern Nevada Water Authority* Board of Directors. The Colorado River Commission has broad statutory authority to establish policies for the management of Nevada’s allocation of power and water resources from the Colorado River and for the development of designated land in Southern Nevada.

Colorado River Compact — An agreement entered into on November 24, 1922 and ratified by the legislatures of the seven states within the Colorado River Basin – Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming – agreeing to the general allocation of the waters of the Colorado River. The compact divided the Colorado River Basin into an *Upper Basin* and a *Lower Basin*, with the division point established at Lees Ferry, a point in the mainstream of the Colorado River approximately 30 river miles south of the Utah-Arizona boundary. The Upper Basin was defined to include those parts of the states of Arizona, Colorado, New Mexico, Utah, and Wyoming within and from which waters naturally drain into the Colorado River system above Lees Ferry, and all parts of these states that are not part of the river’s drainage system but may benefit from water diverted from the system above Lees Ferry. The Lower Basin was defined to include those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which waters naturally drain into the Colorado River system below Lees Ferry, and all parts of these states that are not part of the river’s drainage system but may benefit from water diverted from the system below Lees Ferry. The compact did not apportion water to any state; however, it did apportion to each upper and lower basin the exclusive, beneficial consumptive use of 7,500,000 acre-feet of water per year from the Colorado River system in perpetuity. Further, the compact gave to the Lower Basin the right to increase its annual beneficial consumptive use of such water by 1,000,000 acre-feet. This compact cleared the way for federal legislation for the construction of Hoover Dam (initially named Boulder Dam), Lake Mead, and the All-American Canal to distribute water to the Imperial and Coachella valley’s in southern California. Subsequently, the Upper Basin states entered into the *Upper Colorado River Basin Compact* on October 11, 1948 which provided Arizona to use 50,000 acre-feet of water per year from the upper Colorado River system and apportioned the remaining water to the Upper Basin states according to the following percentages: Colorado, 51.75 percent; New Mexico, 11.25 percent; Utah, 23 percent; and Wyoming, 14 percent. The Lower Basin states could not come to an agreement on apportionment on their own, and in October 1962, the U.S. Supreme Court ruled that of the first 7,500,000 acre-feet of mainstream water in the Lower Basin, California is entitled to 4,400,000 acre-feet (58.67 percent), Arizona to 2,800,000 acre-feet (37.33 percent), and Nevada to 300,000 acre-feet (4.00 percent). Also see “*Law of the River*” [*Colorado River*].

Colored Water — Groundwater extracted from the basin that is unsuitable for domestic use without treatment due to high color and odor exceeding drinking water standards.

Colorimetric Measurement — (Water Quality) A means of measuring unknown chemical concentrations in water by measuring a sample’s color intensity. The specific color of the sample, developed by addition of chemical reagents, is measured with a photoelectric colorimeter or is compared with “color standards” using, or corresponding with, known concentrations of the chemical.

Columnar Ice — Ice consisting of vertical columns of ice crystals massed together.

Colvin Algorithm — A canal flow control structure technique that operates the gates based on the rate of deviation of the water surface level from the setpoint.

Combined Available Chlorine — Concentration of chlorine which is combined with ammonia as chloramine or as other chloro-derivatives yet is still available to oxidize organic matter.

Combined Available Residual Chlorine — The concentration of residual chlorine which is combined with ammonia (NH₃) and/or organic nitrogen in water as a chloramine (or other chloro derivative) yet is still available to oxidize organic matter and utilize its bactericidal properties.

Combined Residual Chlorination — (Water Quality) (1) The application of chlorine to water to produce combined available residual chlorine. This residual can be made up of monochloramines, dichloramines, and nitrogen trichloride. (2) The drinking water treatment method that involves the addition of chlorine to water at levels sufficient to produce, in combination with ammonia and/or organic amines, a *Combine Available Chlorine* residual. This chlorine residual maintains the treatment's disinfecting power throughout the water distribution system. Another approach to water chlorination is *Breakpoint Chlorination*.

Combined Sewer — A sewer that transports surface runoff and human domestic wastes (sewage), and sometimes industrial wastes. Wastewater and runoff in a combined sewer may occur in excess of the sewer capacity and cannot be treated immediately. The excess is frequently discharged directly to a receiving stream without treatment, or to a holding basin for subsequent treatment and disposal.

Combined Sewer Overflow (CSO) — (Water Quality) The condition that occurs when a *Combined Sewer System (CSS)* that is already loaded with wastewater experiences an influx of stormwater runoff from a heavy rain or melting snows. This causes the sewers to overload and excess stormwater and wastewater to discharge directly into receiving streams through overflow ports without treatment.

Combined Sewer System (CSS) — A sewage system that carries both sanitary sewage and storm water runoff. During dry weather, combined sewers carry all wastewater for treatment. During storm events, part of the load may be intercepted to prevent overloading of the processing facility. In this case, the untreated portion is frequently allowed to enter the receiving stream. Also see *Combined Sewer Overflow*.

Comet — A celestial body, observed only in that part of its orbit that is relatively close to the sun, having a head consisting of a solid nucleus surrounded by a nebulous coma up to 2.4 million kilometers (1.5 million miles) in diameter and an elongated, curved vapor tail arising from the coma when sufficiently close to the sun. Comets are thought to consist primarily of ammonia, methane, carbon dioxide, and water.

Comfort Index — See *Temperature-Humidity Index*.

Commercial Use — Water use supplied from other than a common water distribution system to a business such as a truckstop; tourist attraction; eating, drinking, or lodging establishment; commercial campground; convenience store; implement business; salvage business; or any other business or to a livestock confinement feeding operation that exceeds reasonable domestic use.

Commercial Water Use (Withdrawals) — Water for motels, hotels, restaurants, office buildings, and other commercial facilities and institutions, both civilian and military. The water may be obtained from a public supply or may be self-supplied. The terms "water use" and "water withdrawals" are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also see *Industrial Water Use (Withdrawals)*, *Public Water Supply System* and *Self-Supplied Water*.

Commodity Demand Method — A cost allocation method used by water utilities to determine water rates for the various water user groups. This method considers the commodity costs (water, chemicals, power, amount of water use), demand costs (treatment, storage, distribution), customer costs (meter maintenance and reading, billing, collection, accounting) and fire protection costs.

Common Law — A body of court decisions based on custom, traditional usage and precedent, as that of England, rather than codified written laws. *Riparian Water Rights* is a common practice under the common law doctrine.

Community — (1) A naturally occurring, distinctive group of different organisms which inhabit a common environment, interact with each other, and are relatively independent of other groups. (2) A group of people who participate in a social and economic network of statistically significant frequency and within the cultural and geographic boundaries of the network.

Community Assistance Program (CAP) — A grant program funded by the *Federal Emergency Management Agency (FEMA)* with the objective of providing technical assistance for flood mitigation activities and coordinating floodplain management activities in counties and communities participating in the *National Flood Insurance Program (NFIP)*.

Community Based Environmental Protection (CBEP) [EPA] — A relatively new approach to environmental protection conducted by the *U.S. Environmental Protection Agency (EPA)* which integrates environmental management with human needs, considers long-term ecosystem health, and highlights the positive correlation between economic prosperity and environmental well-being. Traditionally, environmental protection programs have focused on a particular medium or problem (i.e. a "Command and Control" approach to environmental protection). These "Command and Control" programs have been very effective at reducing point source pollution and improving environmental quality over the past two and one-half decades. However, some environmental problems, such as *Non-Point Source (NPS)* pollution, which may involve several media types and diffuse sources, are less amenable to such programs. Instead, a solution that seeks to address the various causes of the problems and understand the interrelationships between human behavior and pollution in a specific area may be more appropriate. CBEP supplements and complements the traditional environmental protection approach by focusing on the health of an ecosystem and the behavior of humans that live in the ecosystem's boundaries, instead of concentrating on a medium or particular problem. Therefore, CBEP is place-based, and not media or issue-based, and is based on six key CBEP principles:

- [1] Focus on a Geographic Area;
- [2] Work Collaboratively with Stakeholders;
- [3] Protect and Restore Quality of Air, Water, Land, and Living Resources in a Place as a Whole;
- [4] Integrate Environmental, Economic and Social Objectives (holistic approach);
- [5] Take Action Using Most Appropriate Tools; and
- [6] Use Adaptive Management.

EPA's involvement in place-based, collaborative, and holistic environmental protection includes geographic programs such as

- the *National Estuary Program*, the *Chesapeake Bay Program*, and the *Great Lakes Program*. These programs and others have demonstrated on a large scale the advantages of a CBEP approach.
- Community Component** — (Ecology) Any portion of a biological community. The community component may pertain to the taxonomic group (fish, invertebrates, algae), the taxonomic category (phylum, order, family, genus, species, stock), the feeding strategy (herbivore, omnivore, predator), or the organizational level (individual, population, assemblage) of a biological entity within the aquatic community.
- Community of Interest** — A social group that shares common perspectives, vulnerabilities, and preferences with respect to resource management issues (e.g., hunters, anglers, permittees, and environmentalists).
- Community of Place** — A social group bounded by geographic locality.
- Community Water System (CWS)** — A public water system with 15 or more connections and serving 25 or more year-round residents and thus is subject to the *U.S. Environmental Protection Agency (EPA)* regulations enforcing the *Safe Drinking Water Act (SDWA)*. Also see *Non-Community Water System*, *Transient Water System* and *Non-Transient Non-Community Water System*.
- Compact, Water** — An agreement between states, ratified by Congress, providing for the division and apportionment of waters of an interstate river or other body of water.
- Compaction** — A physical change in soil properties that result in an increase in soil bulk density and a decrease in *Porosity*. The packing together of soil particles by forces exerted at the soil surface, resulting in increased soil density.
- Compatible Pollutants** — Those pollutants that are normally removed by the *Publicly-Owned Treatment Works (POTW)* treatment system. *Biochemical Oxygen Demand (BOD)*, *Suspended Solids (SS)*, and ammonia are considered compatible pollutants.
- Compensation Level** — The level in a body of water, usually occurring at the depth of 1 percent light penetration, which forms the lower boundary of the *Zone of Net Metabolic Production*. Also see *Metabolism*.
- Compensation Point** — The point under water at which plant photosynthesis just equals plant respiration. The water depth defines the lower boundary, where photosynthesis takes place, of the *Euphotic Zone*. Also referred to as the *Compensation Level*.
- Compensatory Mitigation [USACE]** — For purposes of Section 10/404 of the *Clean Water Act (CWA)*, compensatory mitigation is the restoration, creation, enhancement, or in exceptional circumstances, preservation of *Wetlands* and/or other aquatic resources for the purpose of compensating for unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.
- Complete Fertilizer** — Any plant food that contains all three of the primary nutrient elements of nitrogen, phosphorus, and potassium.
- Complete Treatment** — A method of treating water that consists of the addition of coagulant chemicals, flash mixing, coagulation-flocculation, sedimentation, and filtration. Also referred to as *Conventional Treatment* or *Conventional Filtration*.
- Completed Test** — (Water Quality) The third, and last, part of the examination of water for the presence of bacteria of fecal origin. Cultures that are scored as positive in the earlier steps of the analysis (*Presumptive Test* and *Confirmed Test*) are subjected to a verification by inoculating appropriate media (eosin methylene blue agar plates) and performing a gram-positive/gram-negative stain on isolated colonies.
- Completion** — Sealing off access of undesirable water to the well bore by proper casing and/or cementing procedures.
- Complex Stream** — A stream that has begun its second or later cycle of erosion.
- Compliance Cycle** — (Water Quality) The 9-year calendar year cycle, beginning January 1, 1993, during which public water systems must monitor. Each cycle consists of three 3-year compliance periods. The first calendar year cycle begins January 1, 1993 and ends December 31, 2001; the second begins January 1, 2002 and ends December 31, 2010; and the third from January 1, 2011 to December 31, 2019, etc.
- Compliance Monitoring** — (Water Quality) Collection and evaluation of data, including self-monitoring reports, and verification to show whether pollutant concentrations and loads contained in permitted discharges are in compliance with the limits and conditions specified in the permit.
- Compliance Period** — A three year calendar period within a compliance cycle. Each compliance cycle has three three-year compliance periods. Within the first compliance cycle, the first compliance period runs from January 1, 1993 to December 31, 1995; the second from January 1, 1996 to December 31, 1998; and the third from January 1, 1999 to December 31, 2001.
- Compliance Schedule** — (Water Quality) A negotiated agreement between a pollution source and a government agency that specifies dates and procedures by which a source will reduce emissions and, thereby, comply with a regulation.
- Comply (EPA)** — A term used to indicate compliance or adherence with *Clean Water Standards*, specifically with respect to a schedule or plan ordered or approved by a court of competent jurisdiction, the *U.S. Environmental Protection Agency (EPA)*, or a water pollution control agency in accordance with the requirements of the *Federal Water Pollution Control Act (Clean Water Act)* [Public Law 92–500] and regulations issued pursuant thereto.
- Component Landforms** — Commonly small landforms that compose part of the areas of a major landform and were created by partial dissection of, or by alluvial or eolian accretion on that larger, major landform. Component landforms are about the smallest landforms that can be usefully conceived of as single unit. Their morphological parts are landform elements, and the sideslope element may be subdivided into slope components.
- Composite Sample** — (Water Quality) A representative water or wastewater sample made up of individual smaller samples taken at periodic intervals.
- Composite (Proportional) Samples** — A composite sample is a collection of individual samples obtained at regular intervals, usually every one or two hours during a 24-hour time span. Each individual sample is combined with the others in proportion to the rate of flow when the sample was collected. The resulting mixture (composite sample) forms a representative sample and is analyzed to determine the average conditions during the sampling period.

Compost — (1) A mixture that consists largely of decayed organic matter, used for fertilizing and conditioning land. (2) An organic soil amendment or mulch made by gardeners from organic waste materials (dead leaves, some kitchen scraps, etc.). The materials are assembled in a pile where moisture and heat partially decompose them in a matter of months. (3) A mixing of organic waste materials, i.e., garbage, grass clippings, leaves, etc., with soil in a pile to allow soil bacteria to cause decomposition and thereby return of desirable organic material to the soil.

Composting — A controlled microbial degradation of organic waste yield an environmentally sound, nuisance-free product of potential value as a soil conditioner.

Compound — (1) A substance composed of separate elements, ingredients, or parts. Water is a compound consisting of hydrogen and oxygen, chemical symbol H₂O. (2) A substance composed of two or more elements whose composition is constant. For example, common table salt (sodium chloride - NaCl) is a compound consisting of one atom each of sodium (Na) and Chlorine (Cl).

Compound Valley Glacier — A glacier composed of two or more ice streams that arise from tributary valleys.

Comprehensive — In planning, construction, and management, the inclusion of all socially pertinent purposes (or uses) on an interrelated basis, and all economically relevant means of providing for those purposes.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) — Also referred to as the *Superfund Law*, this statute, originally enacted in 1980 and substantially modified in 1986, establishes the U.S. Environmental Protection Agency's (EPA) authority for emergency response and cleanup of hazardous substances that have been spilled, improperly disposed of, or released into the environment. The primary responsibility for response and cleanup is on the generators or disposers of the hazardous substances, with a backup federal response using a trust fund provision. This Act was enacted primarily to correct past mistakes in industrial waste management. The focus of the Act is to locate hazardous waste disposal sites which are creating problems through pollution of the environment and, by proper funding and implementation of study and corrective activities, eliminate the problem from these sites. Current users of CERCLA identified substances must report releases of these substances to the environment when they take place (not just historic ones). This Act is also called the *Superfund Act*. Also see *Superfund Amendments and Reauthorization Act (SARA)*.

Comprehensive Plan — (Natural Resource) A plan for water and related land resources development, that does consider all economic and social factors and provides the greatest overall benefits to the region as a whole.

Comprehensive State Groundwater Protection Program (CSGWPP) [EPA] — A water quality enhancement program sponsored by the U.S. Environmental Protection Agency (EPA) which reflects essentially the same principles as a *Watershed Protection Approach* for surface waters. These programs call for states to define groundwater uses, values, and vulnerabilities. Rather than developing separate plans under various environmental statutes, the EPA is allowing the CSGWPPs to be used for priority setting and management purposes in other media efforts as well. For example, CSGWPPs can be used as a basis for selecting appropriate groundwater clean-up remedies under *Superfund* and for setting priorities for site assessments under *Superfund* and *Resource Conservation and Recovery Act (RCRA)*. For example, the *Surface Water Treatment Rule (SWTR)* requires public water systems to filter their water supplies to remove pathogenic microbiological contaminants. However, if a water supply meets certain source water quality criteria and the community has a watershed program in place that sufficiently protects against these contaminants, EPA allows exemptions from the filtration requirements. Public water suppliers that qualify for these exemptions can thereby avoid the expense of constructing and operating filtration plants. The Underground Storage Tank Program is also using CSGWPPs in making decisions about inspections and enforcement priorities and actions. Also see *Groundwater Use Classification System [EPA]*.

Computed per Capita Contribution — The computed wastewater contribution from a domestic area, based on the population of the area. In the United States, the daily average wastewater contribution is considered to be 100 gallons per capita per day (100 GPCD).

Concentrate — To make a solution or mixture less dilute, as by removing water from a solution.

Concentrated Demand (Water) — Intensive, localized demand, as in an urban area, an irrigation district, or a manufacturing plant having heavy consumption.

Concentrated Flow — See *Channel Flow*.

Concentrated Supply (Water) — Water sources capable of fulfilling concentrated demand, as surface streams, lakes, aquifers, etc.

Concentration — (1) At a specific location or over a defined area of the sea, the ratio of surface area that is covered by sea ice to the total area of the sea surface. (Chemistry) (2) The density or amount of a substance in a solution. (3) The amount of *Solute* present in proportion to the total *Solution*. More specifically, a measure of the average density of pollutants or other constituents, usually specified in terms of mass per unit volume of water or other *Solvent* (e.g., milligrams per liter) or in terms of relative volume of solute per unit volume of water (e.g., parts per million). (4) The process of increasing the amount of a dissolved substance in a solution by evaporating the solvent. (5) The amount of a particular substance in a given quantity of a mixture, solution, or ore; usually stated as a percentage by weight or volume, as weight per unit volume, as molarity (a molar solution contains one gram-mole of solute per liter of solution), or as normality (a normal solution contains one gram equivalent weight of solute per liter of solution).

Concentration Polarization — (1) The ratio of the salt concentration in the membrane boundary layer to the salt concentration in the bulk stream. The most common and serious problem resulting from concentration polarization is the increasing tendency for precipitation of sparingly soluble salts and the deposition of particulate matter on the membrane surface. (2) Used in corrosion studies to indicate a depletion of ions near an electrode. (3) The basis for chemical analysis by a polarograph.

Concentration Time — (1) The time required for water to flow from the farthest portion of a river basin or other watershed to the basin outlet or gauging station. (2) In a storm, the time when the rate of runoff is equal to the rate of precipitation. (3) The period of time required for storm runoff to flow from the most remote point of a catchment or drainage area to the outlet or point under

consideration. Concentration time varies with depth of flow and channel condition.

Concentration/Time (CT) — (Water Quality) The product of residual disinfectant concentration, “C”, in mg/L determined before or at the first customer, and the corresponding disinfectant contact time, “T”, in minutes.

Concordant Flows — Flows at different points in a river system that have the same *Recurrence Interval*, or the same frequency of occurrence. It is most often applied to flood-flows.

Concrete-Gravity Structure — A type of concrete structure in which resistance to overturning is provided only by its own weight.

Condemnation — Taking private property for public use, with compensation to the owner, under the right of *Eminent Domain*.

Condensate — A product of *Condensation*.

Condensation — (1) The cooling of water vapor so that it becomes liquid. (2) (Physics) The process by which a gas or vapor changes to a liquid or solid; also the liquid or solid so formed. (3) (Chemistry) A chemical reaction in which water or another simple substance is released by the combination of two or more molecules. The opposite of *Evaporation*. In meteorological usage, this term is applied only to the transformation from vapor to liquid.

Condensation Funnel — A funnel shaped cloud associated with rotation and consisting of condensed water droplets. Compare with *Debris Cloud*.

Condensation Nuclei — Particles upon which condensation may occur.

Condense — (1) To cause a gas or vapor to change to a liquid. (2) To remove water from a substance, as from milk, for example.

Conditional Water Permit — (1) A water use permit that is conditional upon or granted subject to certain conditions, e.g., specific use, specific quantity, specific place, and specific period of time. (2) An authorization for the permittee to construct any facilities (such as a well and irrigation system) and to begin utilization of the water. A water right and a water permit are not the same thing. Also see *Water Right*.

Conductance — A rapid method of estimating the dissolved solids content of a water supply by determining the capacity of a water sample to carry an electrical current, which is related to the concentration of ionized substances in the water. Also called *Specific Conductance*.

Conductivity — (1) A measure of the ability of a solution to carry an electrical current. (2) (Water) A coefficient, “K”, of proportionality describing the rate at which water can move through a permeable medium.

Conductor Casing — The temporary or permanent steel casing used in the upper portion of the borehole to prevent collapse of the formation during the construction of the well or to conduct the gravel pack to the perforated or screened areas of the casing.

Conduit — (1) A natural or artificial channel through which fluids may be conveyed. (2) (Dam) A closed channel for conveying discharge through, under, or around a dam.

Cone of Depression (COD)/Cone of Influence (COI) — (1) An inverted cone-shaped depression in the *Water Table* that develops around a well as water is withdrawn from it. Also referred to as a *Cone of Influence*. (2) A depression in the water table or potentiometric surface that has the shape of an inverted cone and develops around a well as it is pumped. Its cross-section defines the zone of influence around the well. (3) A cone-like depression of the water table or other *Piezometric Surface* that has the shape of an inverted cone and is formed in the vicinity of a well by withdrawal of water. The surface area included in the cone is known as the area of influence of the well. Also referred to as the *Pumping Cone* and the *Cone of Drawdown*.

Cone of Exhaustion — A cone-shaped depression in the *Water Table* that develops around a well from which water is being withdrawn faster than it can percolate laterally.

Cone of Influence — The depression, roughly conical in shape, produced in the water table by the pumping of water from a well. Also see *Circle of Influence* and *Cone of Depression*.

Confidence Limits — (Statistics) Bounds of statistical probability, e.g., 95 percent, 98 percent, 99 percent, etc., established as part of the testing criteria. The confidence limits express the statistical probability associated with the acceptance of an econometric model's results.

Confined Aquifer — (1) An aquifer in which the groundwater is isolated from the atmosphere by geologic formations of low permeability and in which the water levels of wells completed into the aquifer rise above the top of the aquifer. (2) An aquifer in which groundwater is confined under pressure which is significantly greater than atmospheric pressure. (3) An aquifer containing water between two relatively impermeable boundaries. The water level in a well tapping a confined aquifer stands above the top of the confined aquifer and can be higher or lower than the water table that may be present in the material above it. In some cases the water level can rise above the ground surface, yielding a flowing well. (4) An aquifer or water-bearing subsurface stratum which is bounded above and below by formations of impermeable or relatively impermeable material; a water-bearing formation whose upper boundary is a layer which does not transmit water readily. (5) An aquifer in which groundwater is under pressure significantly greater than atmospheric and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the aquifer itself. See *Artesian Aquifer*.

Confined Groundwater — A body of groundwater covered by material so impervious as to sever the hydraulic connection with overlying groundwater except at the intake or recharge area. Confined water moves in pressure conduits due to the difference in head between intake and discharge areas of the confined water body.

Confined Water (Artesian) — Water under artesian pressure. Water that is not confined is said to be under water table conditions.

Confining Bed — A body of “impermeable” material stratigraphically adjacent to one or more aquifers. It may lie above or below the aquifer. In nature its hydraulic conductivity may actually range from nearly zero to some value distinctly lower than that of the aquifer. In some literature, the term confining bed has now supplanted the terms *Aquiclude*, *Aquitard*, and *Aquifuge*. Also referred to as *Confining Layer*.

Confining Unit — A hydrogeologic unit of relatively impermeable material, bounding one or more aquifers. This is a general term that has replaced *Aquitard*, *Aquifuge*, and *Aquiclude* and is synonymous with *Confining Bed*.

Confirmed Test — (Water Quality) The second stage in the examination of water for the presence of bacteria of fecal origin.

Cultures that are positive on the first portion of the testing procedure (the *Presumptive Test*) are inoculated into tubes of brilliant green lactose bile broth and examined for fermentation when incubated at 35°C (95°F) for 48 hours. If fermentation is present, a third stage, the *Completed Test*, is performed.

Confluence — (1) The point where two or more rivers meet. (2) The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet. (3) The stream or body of water formed by the junction of two or more streams; a combined flood. (4) The meeting or flowing together of two or more streams of glaciers. (5) The place where such a junction occurs, or the body of water produced by this junction.

Confluent — Running or flowing together, as in streams or rivers.

Confluent Growth — (Water Quality) A continuous bacterial growth covering all or part of the filtration area of a membrane filter in which the bacteria colonies are not discrete. In coliform testing, abundant or overflowing bacterial growth which makes accurate measurement difficult or impossible.

Confounding Factors — Variables other than chemical exposure level which can affect the incidence or degree of a parameter being measured. See *Confounding Variable*.

Confounding Variable — (Statistics) A variable which is associated with two or more observed variables and which directly affects the relationship between the observed variables. Often causal relationships are attributed to the observed variables when, in fact, it is the confounding variable that is the true causal factor. By holding the behavior of the confounding variable constant, the relationship between the two observed variables is no longer evident. Also see *Secondary (Indirect) Association*.

Conifer — A tree belonging to the order *Coniferae* with cones and leaves of needle shape or “scalelike.”

Coniferous — Pertaining to *Conifers*, which bear woody cones containing naked seeds.

Conjunctive Management — The integrated management and use of two or more water resources, such as a (groundwater) aquifer and a surface water body.

Conjunctive Operation — The operation of a groundwater basin in combination with a surface water storage and conveyance system. Water is stored in the groundwater basin for later use by intentionally recharging the basin during years of above-normal water supply.

Conjunctive (Water) Use — (1) The planned use of groundwater in conjunction with surface water in overall management to optimize total water resources. (2) The operation of a groundwater basin in combination with a surface water storage and conveyance system. Water is stored in the groundwater basin for later use by intentionally recharging the basin during years of above-average water supply. (3) The combined use of surface and groundwater systems and sources to optimize resource use and prevent or minimize adverse effects of using a single source; the joining together of two sources of water, such as groundwater and surface water, to serve a particular use. (4) The integrated use and management of hydrologically connected groundwater and surface water.

Connate Water — (1) Water entrapped in the pore spaces of a sedimentary rock at the time the sediment was deposited. (2) Water that was trapped in the interstices of a sedimentary or extrusive igneous rock at the time of its deposition. It is usually highly mineralized and frequently saline. (3) Water that was trapped in the interstices of sedimentary or igneous rock; it occurs as a film of water around each grain of sand in the rocks and has existed since the rocks were formed. Also see *Fossil Water*.

Connector System — Conveys water from a single source to a different location typically without intermediate collection of diversions. The connector system is associated with regulation reservoirs and intakes to pumping plants or powerplants.

Consent Decree — (Environmental) A legal document approved by a judge, that formalizes an agreement reached between the U.S. Environmental Protection Agency (EPA) and a *Potentially Responsible Party (PRP)* or parties through which the PRP will conduct all or part of a cleanup action at a *Superfund Site*, cease or correct actions or processes that are polluting the environment, or otherwise comply with EPA initiated regulatory enforcement actions to resolve the contamination at the Superfund site involved. The consent decree describes the actions the PRP will take and may be subject to a public comment period.

Consequent Lake — A lake that occupies an existing depression or some other original inequality in a land surface. Also referred to as *Newland Lake*.

Consequent Stream — (1) A stream following a course that is a direct consequence of the original slope of the surface on which it developed. (2) A stream whose course or direction is dependent on the general form and slope of the existing land surface.

Conservation — (1) The act of preservation from loss, injury, decay, or waste. (2) Increasing the efficiency of energy use, water use, production, or distribution. (3) The careful and organized management and use of natural resource, for example, the controlled use and systematic protection of natural resources, such as forests, soil, and water systems in accordance with principles that assure their optimum long-term economic and social benefits. Also, preservation of such resources from loss, damage, or neglect. (4) (Ecology) Any of various efforts to preserve or restore the Earth's natural resources, including such measures as the protection of wildlife, the maintenance of forests and wilderness areas, the control of air and water pollution, and the prudent use of farmland, mineral deposits, and energy supplies.

Conservation Biology — (Ecology) The branch of the biological sciences concerned with the planning and management of natural resources, and especially with the maintenance of the balance of nature, the diversity of species and genetic material, and natural evolutionary change.

Conservation District — A public organization created under state-enabling law as a special purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries. In the United States, such districts are usually a subdivision of state government with a local governing body and are frequently called a soil conservation district or a soil and water conservation district.

Conservation Easement — A conservation easement is a legal agreement that a property owner makes to restrict the type and amount of development that may take place on his or her property. The easement document is tailored to meet the needs and interests of the landowner. Conservation easements can meet the needs of interested owners of working farms, ranches,

timberlands, sporting properties, and recreational lands, who wish to protect valuable natural resources while retaining ownership of the property. A perpetual conservation easement allows a landowner to protect key natural habitats of a property while continuing to use the area for economic gain or recreation.

Conservation Education — A comprehensive concept that spans curricula from kindergarten through adult, post-graduate programs and links the subject to natural resource conservation, stressing the characteristics and interrelationships in management and use of our natural resources that will result in knowledgeable citizenry with attitudes of responsibility toward the conservation of those natural resources.

Conservation Plan — A collection of material containing land user information requested for making decisions regarding the conservation of soil, water, and related plant and animal resources, along with necessary habitat, for all or part of an operating unit.

Conservation Pool — A residual pool maintained in a reservoir to support fish and other aquatic life.

Conservation Practice — A technique or measure used to meet a specific need in planning and carrying out soil and water conservation programs for which standards and specifications have been developed.

Conservation Standards — Standards for various types of soils and land uses, including criteria, techniques, and methods for the control of erosion and sediment and impacts on plant and animal species and necessary habitat resulting from land disturbing activities.

Conservation Storage — The portion of water stored in a reservoir that can be later released for useful purposes such as municipal water supply, power, or irrigation. Conservation storage is the volume of water stored between dead reservoir storage and flood control storage.

Conservation Storage Capacity — The volume in acre-feet in the reservoir at the crest of the primary spillway.

Conservation Tillage — A level of reduced tillage combined with one or more soil and water conservation practices designed to reduce loss of soil or water relative to conventional tillage. Such activities often take the form of non-inversion tillage that retains productive amounts of residue mulch on the surface.

Conservationist — (Ecology) (1) A person who is professionally trained or qualified to manage *Natural Resources*. (2) A person who advocates or supports the preservation of the earth's natural resources.

Conservative Pollutant — (Wastewater Treatment) A pollutant found in wastewater that is not changed while passing through the treatment processes in a conventional wastewater treatment plant. This type of pollutant may be removed by the treatment processes and retained in the plant's sludges or it may leave in the plant effluent. Heavy metals such as cadmium and lead are conservative pollutants.

Consolidated Aquifer — An aquifer made up of consolidated rock that has undergone solidification or lithification.

Consolidated Assessment and Listing Methodology (CALM) [EPA] — A proposed water monitoring and reporting methodology to be implemented by the *U.S. Environmental Protection Agency (EPA)* and intended to both strengthen and streamline the water quality monitoring, assessment, and listing process for purposes of both sections 305(b) and 303(d) of the *Clean Water Act (CWA)*. Section 305(b) of the CWA requires that states and other jurisdictions submit biennial water quality reports to the EPA. These reports describe the extent to which waters are attaining applicable water quality standards. Under Section 303(d) of the CWA, states are required to identify waters that are not attaining water quality standards, submit a list to the EPA of those impaired waters, and develop *Total Maximum Daily Loads (TMDLs)* for them. The integration of these two requirements aims to help states improve the accuracy and completeness of 303(d) lists and 305(b) reports as well as streamline reporting requirements. The CALM includes six major parts, to include:

- [1] Making decisions on attainment and non-attainment of state water quality standards (covering listing/de-listing decisions);
- [2] Designing comprehensive state monitoring networks that support attainment decisions;
- [3] Reporting and presentation of data;
- [4] Upgrading elements of state monitoring programs;
- [5] Identifying causes and sources of impairment; and
- [6] Addressing issues such as pathogens, nutrients, sedimentation, and fish advisories.

The perceived benefits of the CALM are: (a) increased monitoring of all the nation's waters; (b) improved decision making on water quality standards attainment; (c) more comprehensive listing of impaired waters; and (d) clearer communication to the public on water quality issues in each state and thereby across the nation.

Consolidated Formation — Geological formations which occur naturally and have been turned to stone. The term is sometimes used interchangeably with the word *Bedrock*. It includes rock such as basalt, rhyolite, sandstone, limestone and shale. Typically, these formations will stand at the edges of a bore hole without caving.

Consolidated Ice — (Oceanography) A solid mass of ice of various origins, consolidated by wind and currents.

Consolidation — (Soil Mechanics) Adjustment of a soil in response to increased load; involves squeezing of water from the pores and a decrease in void ratio (pore space). Frequently the geologic term *Compaction* is used instead.

Consolidation Grouting (of a Dam) — The injection of grout to consolidate a layer of the foundation, resulting in greater impermeability and/or strength. Also referred to as *Blanket Grouting*. Also see *Blanket (of a Dam)*.

Consolute — Of or relating to liquid substances that are capable of being mixed in all proportions.

Constant Head Orifice Turnout (Canal) — A calibrated structure containing an adjustable orifice gate and a gate downstream to control a constant head differential across the orifice gate to divert and measure water from a main irrigation canal to a distributing canal.

Constant Volume Operation Method (Canal) — A canal operation that maintains a relatively constant water volume in each canal

pool.

Constituents — Any of the chemical substances found in water. Typically, measurements of such constituents in sampled drinking water may consist of *Total Dissolved Solids (TDS)*, Hardness (concentrations of Calcium and Magnesium, specifically), Sodium, Potassium, Sulfate, Chloride, Nitrate, Alkalinity, Bicarbonate, Carbonate, Fluoride, Arsenic, Iron, Manganese, Copper, Zinc, Barium, Boron, Silica, as well as other physical characteristics and properties such as water color, turbidity, pH, and electro-conductivity (EC).

Constructed Wetlands — (1) Wetlands constructed by man either as part of a *Wetland Banking*, *Wetland Clumping (Aggregation)*, or *Wetland Mitigation* program, or to achieve some other environmental preservation or restoration program. (2) (Water Quality) Wetlands constructed specifically for the purpose of treating waste water effluent before re-entering a stream or other body of water or being allowed to percolate into the groundwater. Also see *Lagoon*.

Construction Joint (of a Dam) — The interface between two successive placings or pours of concrete in a dam's structure where a bond, and not a permanent separation, is intended.

Constructional — (1) Describing a stream or drainage pattern formed by runoff from a constructional landform or surface. (Geology) (2) Describing a landform that was created by any process of upbuilding, such as deposition, volcanic eruption, or diastrophism. (3) Describing an uneroded surface, such as a plain, formed by deposition.

Consumable Water Supply — That amount of river water available for consumption at a given point on the river after existing prior water rights have been met.

Consumer Confidence Reports — (1) An annual report prepared by a water utility to communicate with its consumers. The report provides consumers with information on the source and quality of their drinking water. The report is an opportunity for positive communication with consumers and to convey the importance of paying for good quality drinking water. (2) A *U.S. Environmental Protection Agency (EPA)* regulation requiring community water systems to prepare and provide to their customers annual reports on the quality of the water delivered by the systems.

Consumption, Domestic — The quantity or quantity per capita (person) of water consumed in a municipality or district for domestic uses during a given period, usually one day. Domestic consumption is generally considered to include all uses included in "municipal use of water," in addition to the quantity of water wasted, lost, or otherwise unaccounted for. Also see *Consumption, Municipal*; *Municipal Use of Water*.

Consumption, Industrial — The quantity of water consumed in a municipality or district for mechanical, trade, and manufacturing uses during a given period, usually one day.

Consumption, Municipal — The quantity of water consumed through use in developed urban areas. Also see *Consumption, Domestic*; *Consumptive Use*.

Consumptive Irrigation Requirement (CIR) — The quantity of irrigation water, exclusive of precipitation, stored soil moisture, or groundwater, that is required consumptively for crop production.

Consumptive (Water) Use — (1) Water removed from available supplies without direct return to a water resource system for uses such as manufacturing, agriculture, and food preparation. (2) A use which lessens the amount of water available for another use (e.g., water that is used for development and growth of plant tissue or consumed by humans or animals). (3) A use of water that renders it no longer available because it has been evaporated, transpired by plants, incorporated into products or crops, consumed by people or livestock, or otherwise removed from water supplies. (4) (Agronomy) The amount of water consumed by a plant as it grows; used in determining irrigation needs. (5) The portion of water withdrawn from a surface or groundwater source that is consumed for a particular use (e.g., irrigation, domestic needs, and industry), and does not return to its original source or another body of water. The terms *Consumptive Use* and *Nonconsumptive Use* are traditionally associated with water rights and water use studies, but they are not completely definitive. No typical consumptive use is 100 percent efficient; there is always some return flow associated with such use either in the form of a return to surface flows or as a groundwater recharge. Nor are typically nonconsumptive uses of water entirely nonconsumptive. There are evaporation losses, for instance, associated with maintaining a reservoir at a specified elevation to support fish, recreation, or hydropower, and there are conveyance losses associated with maintaining a minimum streamflow in a river, diversion canal, or irrigation ditch.

Consumptive Use (Lake Waters) — Implies withdrawal of water for such purposes as irrigation, power generation and industrial, municipal and domestic water supplies. Destructive use, such as for waste disposal or as a carrier for sewage, is considered consumptive. Nonconsumptive uses (those that do not reduce the supply) are: recreational, bathing, fishing, boating and hunting, navigable waterways and for aquaculture.

Consumptive Water Use, Irrigation — The quantity of water that is absorbed by the crop and transpired or used directly in the building of plant tissue, together with that evaporated from the cropped area. Does not include runoff or deep percolation in support of the *Crop Leaching Requirement*.

Consumptive Water Use, Net — The consumptive use decreased by the estimated contribution by rainfall toward the production of irrigated crops. Net consumptive use is sometimes referred to as the *Crop Irrigation Requirement*.

Consumptive Water Use Requirement (Crop) — The annual irrigation consumptive use expressed in feet or acre-feet per acre.

Consumptive Water Waste — The water that returns to the atmosphere without benefiting man.

Contact Recreation (Water) — Recreational activities involving a significant risk of ingestion of water, including wading by children, swimming, water skiing, diving and surfing.

Contact Stabilization — (Wastewater Treatment) A modification of the *Activated Sludge Process* wherein a contact basin provides for the rapid adsorption of the waste. In contact stabilization, two aeration tanks are used. One tank is for separate reaeration of the return sludge for at least four hours before it is permitted to flow into the other aeration tank to be mixed with the primary effluent requiring treatment. The process may also occur in one long tank.

Contaminant — (1) In a broad sense any physical, chemical, biological, or radiological substance or matter in the environment.

(2) Any natural or man-made physical, chemical, biological, or radiological substance or matter in water, which is at a level that may have an adverse effect on public health, and which is known or anticipated to occur in public water systems. (3) (Environmental) An undesirable substance not normally present, or an unusually high concentration of a naturally occurring substance, in water, soil, or other environmental medium. (4) (Water Quality) In more restricted usage, a substance in water of public health or welfare concern. Also, an undesirable substance not normally present, or an unusually high concentration of a naturally-occurring substance, in water, soil, or other environmental medium.

Contaminant Plume — An elongated and mobile column or band of a pollutant moving through a surface.

Contaminants, Water — See *Water Contaminants*.

Contaminate — To make impure or unclean by contact or mixture.

Contamination — (1) The pollution of water by the introduction of any substance that reduces or prevents the use of the water for ordinary purposes. (2) The introduction into water of microorganisms, chemicals, toxic substances, wastes, or wastewater in a concentration that makes the water unfit for its next intended use. (3) The degradation of natural water quality as a result of man's activities. There is no implication of any specific limits, since the degree of permissible contamination depends upon the intended end use, or uses of the water.

Contamination [EPA] — Describes media containing contaminants in any form (e.g., non-aqueous phase liquids, dissolved in water, vapors, and solids) that are subject to *U.S. Environmental Protection Agency (EPA)* designated cleanup under the *Resource Conservation and Recovery Act (RCRA)* and are present in concentrations in excess of appropriately protective levels of concern.

Contamination (Water) — Impairment of the quality of water sources by sewage, industrial waste, or other matters to a degree which creates a hazard to public health. Also, the degradation of the natural quality of water as a result of man's activities. There is no implication of any specific limits, since the degree of permissible contamination depends upon the intended end use, or uses, of the water.

Contents (Storage) — The volume of water in a reservoir. Unless otherwise indicated, reservoir content is computed on the basis of a level pool and does not include bank storage.

Continental Divide — A drainage divide separating the rivers which flow toward opposite sides of a continent.

Continental Divide [United States] — A ridge of the Rocky Mountains forming the North American watershed that separates rivers flowing in an easterly direction from those flowing in a westerly direction.

Continental Drift — The theory that continents slowly shift their positions as a result of currents in the molten rocks of the earth's mantle.

Continental Glacier — A thick glacier or sheet of ice of such size that it covers a substantial portion or the entire surface of a continent. Also referred to as a *Continental Ice Sheet*.

Continental Ice Sheet — See *Continental Glacier*.

Continental Shelf — (1) The gently sloping submerged margins of the continents extending from the shoreline to the first prominent break in slope. (2) The submerged shelf of land that slopes gradually from the exposed edge of a continent for a variable distance to the point where the steeper descent (the *Continental Slope*) to the ocean bottom begins, commonly at a depth of about 600 feet (183 meters).

Continentality — The degree to which the climate of a region typifies that of the interior of a large land mass.

Contingency Plan [EPA] - A *U.S. Environmental Protection Agency (EPA)* cleanup approach specified in a remedy decision document that functions as a "backup" remedy in the event that the "selected" remedy fails to perform as anticipated. Also referred to as a *Contingency Remedy* or a *Contingency Measure*.

Continuity Equation — The relation, based on the conservation of mass, that equates the *Volumetric Flow Rate*, Q , of an incompressible fluid in a duct or pipe to the product of the fluid velocity, V , and the cross-sectional area, A , of the duct or pipe, by

$$Q = VA$$

If the area, A , increases, then the velocity, V , must decrease, and conversely. The equation is also applied to liquid flow through a system, stating that the flow in, Q_{in} , flow out, Q_{out} , and the change in the storage volume for a given time must be in balance, or

$$Q_{in} - Q_{out} = \Delta \text{ Storage Volume}$$

Continuous Delivery — A method of delivering water to the farm headgate from an irrigation conveyance system on a continuous basis, as opposed to a demand delivery where flows are delivered on a rotational time schedule and/or upon demand.

Continuous Demand (Water) — Demand incident generally on a year-round basis, as contrasted with seasonal or other periodic demand.

Continuous Discharge — A routine release to the environment that occurs without interruption, except for infrequent shutdowns for maintenance, process changes, etc.

Continuous-Record Station [USGS] — A gaging station site that meets either of the following conditions: (1) Stage or streamflow are recorded at some interval on a continuous basis; the recording interval is usually 15 minutes, but may be less or more frequent; (2) water quality, sediment, or other hydrologic measurements are recorded at least daily.

Continuous Recorder (Gage) — A device which measures stream flow levels on a continual basis.

Continuous Sample — A flow of water from a particular place in a plant to the location where samples are collected for testing. This continuous stream may be used to obtain grab or composite samples. Frequently, several taps (faucets) will flow

- continuously in the laboratory to provide test samples from various places in a water treatment plant. May be used to obtain *Grab Samples* or *Composite Samples*.
- Contour Ditch** — An irrigation ditch laid out approximately on the contour, or elevation of the land.
- Contour Farming** — A conservation-based method of farming in which all farming operations (for example, tillage and planting) are performed across (rather than up and down) the slope. Ideally, each crop row is planted at right angles to the ground slope.
- Contour Flooding** — Irrigation method resulting in flooding fields from *Contour Ditches*.
- Contour-Furrow Irrigation** — The application of irrigation water in furrows that run across the slope with a forward grade in the furrows.
- Contour Furrows** — Furrows plowed approximately on the contour on pasture and rangeland to prevent runoff and increase infiltration; also, furrows laid out approximately on the contour for irrigation purposes.
- Contour Plowing** — A soil tilling technique that follows the shape of the land to minimize erosion.
- Contour Strip Farming** — A kind of *Contour Farming* in which row crops are planted in strips, between alternating strips of close-growing, erosion-resistant forage crops.
- Contour Stripping** — (Mining) A type of stripping in rolling to steep terrain. Removal of the overburden from the mineral seam starting at the outcrop and proceeding around the hillside. Overburden is deposited on the outer edge of the bench. Successive cuts are made until the depth of overburden becomes too great for economical retrieval of the ore.
- Contour Trenching** — Development of water storage *Detention* or *Retention Facilities* along the contour by excavation and placement of soils as an embankment along the downstream side. Intervals vary with precipitation, slope, and soil.
- Contourite** — (Oceanography) A marine sediment deposited along contours by swift bottom currents.
- Contract (USBR)** — Any repayment or water service contract between the United States and a district providing for the payment of construction charges to the federal government, including normal operation, maintenance, and replacement costs pursuant to federal reclamation law. All water service and repayment contracts are considered contracts even if the contract does not specifically identify that portion of the payment which is to be attributed to operation and maintenance and that which is to be attributed to construction.
- Contract Rate (USBR)** — The repayment or water service rate set forth in a contract to be paid by a district to the federal government.
- Contrail** — A visible trail of streaks of condensed water vapor or ice crystals sometimes forming in the wake of an aircraft. Also referred to as *Vapor Trail*.
- Contributing Area** — That portion of a watershed which contributes to measured runoff under normal conditions.
- Control** — A natural constriction of the channel, a long reach of the channel, a stretch of rapids, or an artificial structure downstream from a *Gaging Station* that determines the *Stage-Discharge Relation* at the gage. A control may be complete or partial. A complete control exists where the stage-discharge relation at a gaging station is entirely independent of fluctuations in stage downstream from the control. A partial control exists where downstream fluctuations have some effect upon the stage-discharge relation at a gaging station. A control, either partial or complete, may also be shifting. Most natural controls are shifting to a degree, but a shifting control exists where the stage-discharge relation experiences frequent changes owing to impermanent bed or banks.
- Control Dam** — A dam or structure with gates to control the discharge from the upstream reservoir or lake.
- Control Points (Horizontal and Vertical)** — Small monuments that are securely embedded in the surface of a dam and used to detect any movement with respect to *Permanent Monuments* placed away from the dam itself.
- Control Scheme (Canal)** — The collection of methods and algorithms brought together to accomplish control of a canal system.
- Control Structure [USGS]** — A structure on a stream or canal that is used to regulate the flow or stage of the stream or to prevent the intrusion of saltwater.
- Control System (Canal)** — An arrangement of electronic, electrical, and mechanical components that commands or directs the regulation of a canal system.
- Controlled Drainage** — (Irrigation) Regulation of the water table to maintain the water level at a depth favorable for optimum crop growth.
- Controlled Spillway** — A regulating structure, usually part of a dam or other impoundment device or structure, in which controllable gates are used to control the volume of spilled or released water. Contrast with *Uncontrolled Spillway*.
- Controlled Volume Operation Method (Canal)** — An operation in which the volume of water within a canal reach between two check structures is controlled in a prescribed manner for time variable inflows and outflows such as off-peak pumping or canal-side deliveries.
- Convection** — (1) (Physics) Heat transfer in a gas or liquid by the circulation of currents from one region to another; also fluid motion caused by an external force such as gravity. (2) (Oceanography) The movement and mixing of ocean water masses, usually caused by temperature differences between them. (Meteorology) (3) The predominantly vertical atmospheric motions that result in vertical transport and mixing of atmospheric properties. (4) The phenomenon occurring where large masses of warm air, heated by contact with a warm land surface and usually containing appreciable amounts of moisture, rise upward from the surface of the earth. The vertical movement of air resulting from vertical instability in an air mass which is produced either by heating from below or by cooling aloft.
- Convective Storm** — A rain event that results from unequal heating of the land surface such that a rising column of air cools beyond the dew point and becomes unstable, producing a *Cumulonimbus Cloud*, typically exhibiting violent local winds, high intensity rainfall over a small area and for a short duration, hail, thunder and lightning.
- Convective Clouds** — Clouds generated by the rising of air over a relatively warm land mass.
- Convective Precipitation** — Precipitation resulting from vertical movement of moisture-laden air, which upon rising, cools and

precipitates its moisture.

Convective Transport — The component of movement of heat or mass induced by thermal gradients in groundwater. Also see *Advection*.

Conventional Activated Sludge — A process in which influent and recycled sludge enter at the head of the aeration tank.

Conventional Filtration — A method of treating water to remove particulates. The method consists of the addition of coagulant chemicals, flash mixing, coagulation, flocculation, sedimentation, and filtration. Also called *Complete Treatment*. Also see *Direct Filtration* and *In-Line Filtration*.

Conventional Filtration Treatment — A series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal.

Conventional Method (Canal) — Where operations personnel (ditchrider and watermaster) control the canal system onsite. Labor-saving devices and machinery may be used to assist in the control of the canal facilities.

Conventional Systems — (Water Quality) Systems that have been traditionally used to collect municipal wastewater in gravity sewers and convey it to a central primary or secondary treatment plant prior to discharge to surface waters.

Conventional Tillage — The traditional method of farming in which soil is prepared for planting by completely inverting it with a moldboard plow. Subsequent working of the soil with other implements is usually performed to smooth the soil surface. Bare soil is exposed to the weather for some varying length of time depending on soil and climatic conditions.

Conventional Tilling — Tillage operations considered standard for a specific location and crop and that tend to bury the crop residues; usually considered as a base for determining the cost effectiveness of control practices.

Conventional Treatment — See *Conventional Filtration*. Also called *Complete Treatment*.

Conventional Water — A natural freshwater supply as opposed to desalted or brackish water.

Convergence — (1) The boundary separating turbid river water from clear lake water. (Oceanography) (2) The joining of ocean currents or water masses that differ in density, temperature, or salinity, resulting in the sinking of the denser, colder, or more saline water. (3) The zone in which such sinking occurs. (4) (Meteorology) The net flow of air into a given region.

Convergence Zone — (1) (Oceanography) An ocean region where a convergence of water occurs. (2) (Acoustics) An ocean region in which the intensity of sound is 10 to 20 decibels greater than it would be in a free field, due to various conditions of temperature and pressure that bend all the sound waves toward these areas. Occurring at depths between 750 and 4500 meters, this channel produces patterns of sound refraction that are used in sonar technology.

Conveyance Loss — Water that is lost in transit from delivery systems such as pipes, canals, conduits, or ditches by leakage, seepage, spillage, evaporation, or evapotranspiration by plants growing in or near the channel. Generally, these conveyance losses are not available for further use; however, leakage from an irrigation ditch, for example, may percolate to a ground-water source and be available for further use.

Cooking Liquor — The solution containing calcium bisulfite, sodium sulfide, or sodium hydroxide, along with other compounds, in which wood chips are digested in the manufacture of chemical wood pulps.

Coolant — An agent, such as water, that produces cooling as by drawing off heat by circulating through an engine or by bathing a mechanical part.

Cooling Pond — Usually a man-made water body used by power plants or large industrial plants that enables the facility to recirculate once-through cooling water. The water levels in the pond are usually maintained by rainfall or augmented by pumping (withdrawal) water from another source. Also see *Cooling Water* and *Once-Through Cooling Water*.

Cooling Tower — A large tower or stack that is used for heat exchange of once-through cooling water generated by steam condensers. Hot water from the plant is sprayed in the tower and exchanges heat with the passing air. The water is then collected at the bottom of the tower and used again. A small amount of water is lost (consumed) through evaporation in this process. Also see *Cooling Water* and *Once-Through Cooling Water*.

Cooling Water — Water used for cooling purposes by electric generators, steam condensers, large machinery or products at industrial plants, and nuclear reactors. Water used for cooling purposes can be either fresh or saline and may be used only once or recirculated multiple times. Also see *Cooling Pond* and *Once-Through Cooling Water*.

Cooling Water Consumption (Power) — The cooling water which is lost to the atmosphere, caused primarily by evaporation due to the temperature rise in the cooling water as it passes through the condenser. The amount of consumption (loss) is dependent on the type of cooling employed — *Once-Through Cooling Water*, *Cooling Pond*, or *Cooling Tower*.

Cooling Water Load — The waste heat energy dissipated in the cooling water.

Cooling Water Required (Power) — The amount of water needed to pass through the condensing unit in order to condense the steam to water.

Cooperative Extension — Associated with state land grant institutions of higher education, cooperative extension provides experts in agriculture and agribusiness, community and economic development, natural resources, family living and youth development. Most state extension faculty and staff are county-based giving them extensive knowledge in local conditions and concerns. Extension stresses partnership with the various levels of government, volunteers and the private sector in carrying out programming activities.

Coordinated Resource Management and Planning — A planning process used by the U.S. Department of the Interior, *Bureau of Land Management (BLM)* that includes public users, interest groups, agencies and affected individuals in the decision-making process before on-the-ground implementation of an activity plan.

Coordinated Resource Plan — A conservation plan including privately-owned land and public land.

Coral (or Corals) — Corals themselves are tiny animals which belong to the group *cnidaria* (the “c” is silent). Other *cnidarians* include hydras, jellyfish, and sea anemones. Corals are sessile animals, meaning they are not mobile but stay fixed in one place. They feed by reaching out with tentacles to catch prey such as small fish and planktonic animals. Corals live in colonies

consisting of many individuals, each of which is called polyp, and secrete a hard calcium carbonate skeleton, which serves as a uniform base or substrate for the colony. The skeleton also provides protection, as the polyps can contract into the structure if predators approach. It is these hard skeletal structures that build up coral reefs over time. The calcium carbonate is secreted at the base of the polyps, so the living coral colony occurs at the surface of the skeletal structure, completely covering it. Calcium carbonate is continuously deposited by the living colony, adding to the size of the structure. Growth of these structures varies greatly, depending on the species of coral and environmental conditions - ranging from 0.3 to 10 centimeters per year. Different species of coral build structures of various sizes and shapes ("brain corals," "fan corals," "elkhorn corals," etc.), creating amazing diversity and complexity in the coral reef ecosystem. Various coral species tend to be segregated into characteristic zones on a reef, separated out by competition with other species and by environmental conditions. In a symbiotic relationship, corals are dependent upon *Zooxanthellae*, a form of algae which, in turn, is dependent on the corals for proximity to light needed for photosynthesis. *Zooxanthellae* account for up to 75 percent of the biomass of reef-building corals and also provide the coral with up to 90 percent of its nutrition.

Coral Bleaching — A condition occurring in coral reefs when coral polyps lose their *Zooxanthellae*, which are the plant-like algae that live inside the coral polyps and perform photosynthesis, producing food which is shared with the coral. The death or expulsion of the brightly-colored zooxanthellae exposes the white calcium carbonate skeletons of the coral colony, turning the coral reef a brilliant white. There are a number of stresses or environmental changes that may cause bleaching and the expulsion of the zooxanthellae, including disease, excess shade, increased levels of ultraviolet radiation, sedimentation, pollution, salinity changes, and increased water temperatures. The coral polyps often survive such events, particularly when the symbiotic algae are expelled due to unusual patterns of ocean warming. In such cases the coral regains its color after the zooxanthellae return.

Coral Chemistry and Growth Patterns (Geoindicator) [GCRI] — The combination of abundant geochemical tracers, sub-annual time resolution, near-perfect dating capacity, and applicability to both current and past climatic changes establishes corals as one of the richest natural environmental recorders and archives. A 30 centimeter (cm) diameter coral colony growing at an average rate of 1 cm/year will provide 20-25 years of baseline data, whereas massive colonies 3-6 meters high may provide historical data for extensive tracts of tropical ocean, such as are not otherwise available. Corals can be used to monitor environmental changes in the oceans and nearby coastal zone. The health, diversity and extent of corals, and the geochemical makeup of their skeletons, record a variety of changes in the ocean surface water. These include temperature (Oxygen – $\delta^{18}\text{O}$, Strontium/Calcium – Sr/Ca, Uranium/Calcium – U/Ca, growth patterns), salinity ($\delta^{18}\text{O}$, U/Ca), fertility (Barium/Calcium – Ba/Ca, Cadmium/Calcium – Cd/Ca), insolation (Carbon – ^{13}C , growth patterns), precipitation ($\delta^{18}\text{O}$, Sr/Ca, U/Ca), winds (Manganese/Calcium – Mn/Ca), sea levels (micro-atoll growth patterns), storm incidence (age of reef of tilted or toppled corals), river runoff (diversity and mortality, fluorescence, trace elements such as Ba), and human inputs (radionuclides, Phosphorus – P, heavy metals such as Lead – Pb, Cd). Corals in coastal waters are susceptible to rapid changes in salinity and suspended matter concentrations and may be valuable indicators of the marine dispersion of agricultural, urban, mining and industrial pollutants through river systems, as well as the history of contamination from coastal settlements and development. See *Geoindicators* [U.S. Global Change Research Information Office]. Also see *Coral Bleaching*.

Coral Reefs — The intricate and frequently expansive calcium carbonate structure representing the skeletal structure of a *Coral* colony of both living and dead coral polyps. Because the *Zooxanthellae*, an algae upon which corals are dependent, are themselves dependent on light for photosynthesis, reef-building corals are found in shallow, clear water where light can penetrate down to the coral polyps. Reef-building coral communities also require tropical or sub-tropical temperatures and therefore exist globally in a band approximately 30 degrees north to 30 degrees south of the equator (or where the average monthly temperature exceeds 18EC (64EF) throughout the year). Coral reefs are generally classified in three types:

- [1] **Fringing Reefs** – the most common type of coral reef, projecting seaward directly from the shores of islands or continents;
- [2] **Barrier Reefs** – coral "platforms" separated from the adjacent land by a bay or lagoon; the longest barrier reefs occur off the coasts of Australia and Belize; and
- [3] **Atolls** – coral structures which rest on the tops of submerged volcanoes; they are usually circular or oval with a central lagoon; parts of the atoll may emerge as islands; over 300 atolls are found in the South Pacific Ocean.

The coral reef itself is actually a component, albeit a critical one, of a larger shallow-water ocean ecosystem. The coral community is really a system that includes a collection of biological communities, representing one of the most diverse ecosystems in the world. For this reason, coral reefs often are referred to as the "rainforests of the oceans."

Core — (Geology) The central portion of the earth below the *Mantle*, beginning at a depth of about 2,900 kilometers (1,800 miles) and probably consisting of iron and nickel. It is made up of a liquid outer core and a solid inner core.

Core Wall (of a Dam) — A wall built of impervious material, usually concrete or asphaltic concrete, in the body of an *Embankment Dam* to prevent leakage.

Coriolis Effect — (Climatology and Oceanography) The Coriolis effect, named for French physicist Gaspard Coriolis (1792–1843), is an imaginary force that appears to be exerted on an object moving within a rotation system. The apparent force is simply the acceleration of the object caused by the rotation. This effect may be seen on a large scale in the movement of winds and ocean currents on the rotating earth. It dominates weather patterns, producing the counterclockwise flow observed around low-pressure zones in the Northern Hemisphere and the clockwise flow around such zones in the Southern Hemisphere. This effect is also responsible for the rotation of water funnels in the drains of tubs and water basins; the funnels will rotate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Along the equator, there will be no such rotation.

Corn Snow — Snow that has melted and refrozen into a rough, granular surface.

Corona — (Astronomy) (1) A faintly colored luminous ring appearing to surround a celestial body visible through a haze or thin cloud of water vapor, especially such a ring around the moon or sun, caused by the diffraction of light from suspended matter

in the intervening medium. Also referred to as *Aureole*. (2) A set of one or more prismatically colored rings of small radii, concentrically surrounding the sun or moon when veiled by a thin cloud. The corona is due to diffraction and reflection by water drops.

Corporation Stop — A water service shutoff valve located at a street water main. This valve cannot be operated from the ground surface because it is buried and there is no valve box. Also called a “corporation cock”.

(U.S. Army) Corps of Engineers (COE) — See *(United States) Army Corps of Engineers (COE)*.

Corrasion — The wearing away of earth materials through the cutting, scraping, scratching, and scouring effects of solid material carried by water or air.

Correlation — (Statistics) A statistical means to measure the degree of “coincidence of change” between two variables, producing a value of variance termed the *Correlation Coefficient*. In strict correlation analysis, no inference of causation, i.e., one variable being “explained” by the variations of another, is made. Therefore, high correlations do not provide for an inference of causality; one must use previous information that the two sampled variables are indeed related to one another. The concept of the *Coefficient of Determination*, on the other hand, used as a common measure of “*Goodness of Fit*” in *Regression Analysis*, is used to assess the degree of causation between two variables or between one or more independent variables and a single dependent variable. The coefficient of determination is equivalent to the square of the correlation coefficient and reflects the percent of change in the dependent (explained) variable that is explained by the variations in the independent (explanatory) variable.

Correlation Coefficient (R) — (Statistics) A measure of the coincidence of change between two variables. The use of the correlation coefficient makes no inference as to causation, i.e., one variable causing changes to occur in another; it only represents a measure of the simultaneous behavior between two variables which either are related or are being affected similarly by a third variable. The value of the correlation coefficient will vary between -1.00 (-100 percent) and $+1.00$ ($+100$ percent) with higher numbers representing stronger levels of coincidence of changes. Positive correlation coefficients denote that the two series or variables evidence changes in the same direction while negative correlation coefficients reflect an inverse relationship between changes in one series and the changes in the other. Compare to the *Coefficient of Determination* (R^2).

Correlative — Having a mutual or reciprocal relation, that is, that the existence of one necessarily implies the existence of the other, as in *Correlative (Water) Rights*.

Correlative Estimate — A discharge or stream flow estimate determined by *Correlation*, or by comparisons to other, possibly influencing factors, e.g., rainfall, snowpack, levels of upstream lakes and reservoirs, flows in other, proximate streams, etc. A correlative estimate represents a likely value of the discharge or flow for any particular period – commonly a month – according to a specified method of analysis and the explanatory variables chosen. The resultant estimate will be based on statistical probability as prescribed by the historical correlation of the two or more measures being used.

Correlative Water Rights — (1) Certain rights of land owners over a common groundwater basin are coequal, or correlative, so that any one owner cannot take more than his share even if the rights of others are impaired. In this regard they must share the water of that source until it is exhausted, irrespective of the consequences. (2) Another term for the *Reasonable Use Doctrine* relating to percolating and riparian waters. In the groundwater context, the doctrine of correlative rights will generally limit the appropriation of groundwater to the landowner’s proportionate share of the water available.

Corrosion — (1) The act or process of dissolving or wearing away metals. (2) The gradual decomposition or destruction of a material by chemical action, often due to an electrochemical reaction. Corrosion may be caused by: (a) stray current electrolysis; (b) galvanic corrosion caused by dissimilar metals; or (c) differential concentration cells. Corrosion starts at the surface of a material and moves inward.

Corrosion Inhibitor — A substances that slows the rate of corrosion of metal plumbing materials by water, especially lead and copper materials, by forming a protective film on the interior surface of those materials.

Corrosive — A substance that deteriorates material, such as pipe, through electrochemical processes.

Corrosivity — An indication of the corrosiveness of a water. The corrosiveness of a water is described by the water’s pH, alkalinity, hardness, temperature, total dissolved solids, dissolved oxygen concentration, and the *Langelier Index*.

Corrugation Irrigation — Spreading water by directing it into small channels across the field. Also referred to as *Furrow Irrigation*.

Cost/Benefit Analysis — (1) A quantitative evaluation of the costs which would be incurred versus the overall benefits to society of a proposed action such as the establishment of an acceptable dose of a toxic chemical. (2) Estimates and comparisons of short-term and long-term costs (losses) and benefits (gains) from an economic decision. If the estimated benefits exceed the estimated costs, the decision to buy an economic good or provide public good is considered worthwhile. Also referred to as *Benefit/Cost Analysis*. Also see *Benefit-Cost Ratio*.

Cost Depletion — A method by which the costs of natural resources are allocated to depletion over the accounting periods that make up the life of the asset. Cost depletion is computed by (1) estimating the total quantity of a mineral or other resources acquired and (2) assigning a proportionate amount of the total resource cost to the quantity extracted during the accounting period. Also see *Percentage Depletion*.

Cost Sharing — A publicly financed program through which society, as the beneficiary of environment protection, shares part of the cost of pollution control with those who must actually install the controls.

Coulee — (1) (Western U.S.) A deep gulch or ravine with sloping sides, often dry in summer. (2) (Louisiana and Southern Mississippi) A streambed, often dry according to the season; a small stream, bayou, or canal. (3) (Upper Midwest) A valley with hills on either side. (4) (Geology) A stream of molten lava; a sheet of solidified lava.

Couloir — A deep mountain gorge or gully.

Coulomb — A measurement of the amount of electrical charge conveyed in one second by an electric current of one ampere. One coulomb equals about 6.25×10^{18} electrons (6,250,000,000,000,000 electrons).

Council on Environmental Quality (CEQ) [NEPA] — The Council on Environmental Quality coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. The Council's Chair, who is appointed by the President with the advice and consent of the Senate, serves as the principal environmental policy adviser to the President. In addition, CEQ reports annually to the President on the state of the environment; oversees federal agency implementation of the environmental impact assessment process; and acts as a referee when agencies disagree over the adequacy of such assessments. Congress established CEQ within the Executive Office of the President as part of the *National Environmental Policy Act (NEPA)* of 1969 to develop and recommend to the President national policies to improve environmental quality; and to oversee programs and activities of the Federal Government in its implementation of NEPA. Additional responsibilities were provided by the Environmental Quality Improvement Act of 1970. In enacting NEPA, Congress recognized that nearly all federal activities affect the environment in some way and mandated that before federal agencies make decisions, they must consider the effects of their actions on the quality of the human environment. NEPA assigns CEQ the task of ensuring that federal agencies meet their obligations under the Act. The challenge of harmonizing our economic, environmental and social aspirations has put NEPA at the forefront of our nation's efforts to protect the environment. The three-member Council operates under Title II authority to carry out overall NEPA policy, including oversight of individual agencies' NEPA compliance under Council regulations issued in 1979 (40 CFR 1500). Title II also requires an annual Environmental Quality report by the President to Congress, a function for which the Council in recent years has relied on the *U.S. Environmental Protection Agency (EPA)* for major assistance. As described in its seventeenth annual report:

"CEQ promulgates and interprets regulations implementing the procedural provisions of the National Environmental Policy Act which are binding on all Federal agencies. This responsibility includes: informal consultations with federal agencies regarding appropriate implementation of NEPA procedures; approval of federal agency NEPA procedures; informal consultation with state and local governments and private citizens regarding NEPA procedures; commenting on proposed legislation and testimony which is NEPA related; designating lead agencies for the purpose of preparing environmental impact statements (EIS); making determinations on requests for emergency exemptions and alternative procedures for supplemental EIS(s); handling formal referrals to CEQ of major [controversial] federal actions; participating in international activities related to environmental impact assessment; and disseminating information about the NEPA process to interested parties."

Counter Flow — An arrangement by which two streams of materials, usually one liquid and one solid, are handled so that each stream entering the process contacts the other stream.

Countercurrent — A current flowing in an opposite direction to a main or comparative current.

Coupon — (1) A piece of material, usually metal, used to test the rate of corrosion or scale buildup due to exposure to specific water conditions. (2) A steel specimen inserted into water to measure the corrosiveness of water. The rate of corrosion is measured as the loss of weight of the coupon (in milligrams) per surface area (in square decimeters) exposed to the water per day. See *Coupon Test*.

Coupon Test — A method of determining the rate of corrosion or scale formation by placing metal strips (or coupons) of a known weight in the pipe.

Course (Water) — The route or path taken by flowing water, such as a stream or river.

Covariance — (Statistics) A measure of the linear association between two variables. If both variables are always above and below their means at the same time, the covariance is said to be positive. If one variable is above its mean when the other variable is below its mean and vice versa, the covariance is said to be negative. The value of the covariance is dependent upon the units in which each variable is measured whereas the *Correlation Coefficient* is a measure of this association which has been normalized and is therefore "unit free."

Cove — A small sheltered inlet, creek, or bay; a recess in the shore.

Cover — (1) Vegetation or other material providing protection to a surface. (2) The area covered by live above-ground parts of plants. (3) Anything that provides visual or physical protection for an animal. Cover for fish includes vegetation that overhangs the water, undercut banks, rocks, logs and other woody debris, turbulent water surfaces, and deep water.

Cover Crop — A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of regular crop production or between trees and vines in orchards and vineyards.

Cradle — A supporting structure shaped to fit the conduit it supports.

Cranberry Bog — A bog dominated by this mat-forming evergreen shrub; common in eastern North America.

Crater Lake — (1) A lake formed in a crater. (2) A deep, freshwater lake that is formed by the accumulation of rainwater and groundwater within a volcanic crater or caldera. *Caldera* are basins formed by the collapse of magma in the vents of volcanoes. *Maars* are volcanic basins formed by single explosive eruptions. Depressions in the earth's surface made by impact of falling meteors are also called craters, although the existence of only a few crater lakes of this origin has been clearly established. See, for example, *Crater Lake [Oregon]*.

Crater Lake [Oregon] — A *Caldera*, which subsequently filled with water, that was formed by collapse during a catastrophic eruption of approximately 12 cubic miles (50 cubic km) of magma, 6,845 +/- 50 (carbon-14) years before present (B.P.). The 5 by 6 mile (8 by 10 km) caldera lies in the remains of Mount Mazama, a *Pleistocene Epoch* stratovolcano cluster covering 154 square miles (400 square km) in the southern Oregon Cascades. Prior to its climactic eruption, Mount Mazama's summit had an elevation of between 10,800-12,000 feet (3,300-3,700 meters). Its southern and southeastern flanks were deeply incised by glacial valleys, now beheaded, that form U-shaped notches in the caldera wall. Mazama was one of the major volcanoes of the High Cascades and is the largest edifice between Mount Shasta and the Three Sisters volcanoes. The widespread dispersion of Mazama tephra (ash) has been used extensively as a stratigraphic indicator, i.e., deposits have been used to precisely date

archeological finds throughout the western United States where this ash was extensively deposited. Much of the climactic pumice fall was carried to the northeast, while only sparse, thin patches of redeposited pumice are present near the caldera rim around the southwest quadrant. The caldera, now filled by Crater Lake, was produced by an eruption that destroyed a volcano the size of Mount St. Helens and sent volcanic ash as far east as Nebraska. Local Native Americans, namely the Klamath people, witnessed the collapse of Mount Mazama and kept the event alive in their legends. The Klamaths revered the lake and the surrounding area, keeping it undiscovered by white explorers until 1853. U.S. Geological Survey sonar readings made in 1959 established the lake's deepest point at 1,932 feet, making it one of the deepest lakes in the world and certainly one of the bluest. On May 22, 1902, President Theodore Roosevelt signed the bill giving Crater Lake national park status.

Creation [Wetland] — The establishment of a *Wetland* or other aquatic resource where one did not formerly exist.

Creek — (1) Any natural stream of flowing water, regarded as larger than a brook but smaller than a river. (2) A small inlet, bay, or narrow recess in the shore of a lake, river, or sea. (3) A small stream of water which serves as the natural drainage course for a drainage basin; a flowing rivulet or stream of water normally smaller than a river and larger than a brook. The term is often relative according to size and locality. Some creeks in a humid region would be called rivers if they occurred in an arid area.

Creep — (1) The imperceptibly slow, more or less continuous downslope movement of *Regolith*. (2) Slow mass movement of soil and soil material down relatively steep slopes, primarily under the influence of gravity but facilitated by saturation with water and by alternate freezing and thawing.

Creeper — A grappling device for dragging bodies of water, such as lakes or rivers.

Crenulation — Small-scale folding that is superimposed on larger-scale folding. Crenulations may occur along the cleavage planes of a deformed rock.

Creosotes — Chemicals used in wood preserving operations and produced by distillation of tar, including *Polycyclic Aromatic Hydrocarbons* and *Polynuclear Aromatic Hydrocarbons* (PAHs and PNAs). Contaminating sediments, soils, and surface water, creosotes may cause skin ulcerations and cancer with prolonged exposure.

Crest — (1) The top of a dam, dike, or spillway, which water must reach before passing over the structure; in international usage it refers to the crown of an overflow section of a dam. (2) The summit or highest point of a wave. (3) The highest elevation reached by flood waters flowing in a channel as in *Crest Stage* or *Flood Stage*.

Crest Gage — An instrument used to obtain a record of flood crests at sites where recording gages are not installed.

Crest Gate — A temporary or movable gate installed on top of a spillway crest to provide additional storage or prevent flow over the crest.

Crest Length — The length of the top or crest of a dam, including the length of the spillway, powerhouse, navigation lock, fish pass, etc., where these structures form part of the length of a dam. If detached from a dam, these structures would not be included in the crest length.

Crest Stage — (1) The highest elevation reached by the water surface at a given point during a stream rise. (2) The highest value of river *Stage* (or streamflow) attained in a flood.

Crest Width (or Top Thickness) — The thickness or width of a dam at the level of the top (crest) of the dam. In general, the term "thickness" is used for *Gravity* and *Arch Dams* and the term "width" is used for other dams.

Crevasse — (1) A deep crack or fissure, especially in a glacier. (2) A break in the levee of a river, dike, or similar structure. Also see *Levee*.

Crevasse Hoar — A deposit of thin ice crystals having the shape of a leaf, plate, or cup, forming and growing in a glacial crevasse or other large, open space where water vapor can condense under calm, still conditions.

Crib Dam — A barrier or form of *Gravity Dam* constructed of timber forming bays, boxes, cribs, crossed timbers, gabions or cells that are filled with earth, stone or heavy material. Also see *Dam*.

Crick — (Inland Northern U.S. and Western U.S.) Variant of *Creek*.

Criteria — Water quality conditions which are to be met in order to support and protect desired uses.

Criteria, Testing (R^2 , t -Statistic, and F -Statistic) — (Statistics) In criteria testing of the appropriateness of an econometric forecast model's structure (*Specification*), certain testing criteria are used most frequently. Specifically, the *Coefficient of Determination*, R^2 , is used as an overall measure of the "goodness of fit," the t -Statistic, is used as a measure of the appropriateness of individual explanatory variables, and the F -Statistic, is used as a measure of the appropriateness of the inclusion or exclusion of a set of explanatory variables simultaneously. Also see *Model* and *Regression Analysis*.

Criteria, WHPA — Conceptual standards that form the basis for *Wellhead Protection Area (WHPA)* delineation. WHPA criteria can include distance, drawdown, time of travel, assimilative capacity, and flow boundaries. See *Wellhead Protection Area (WHPA)* and *Wellhead Protection (Program)*.

Critical — (Chemistry and Physics) Of or relating to the value of a measurement, such as temperature, at which an abrupt change in a quality, property, or state occurs. For example, a critical temperature of water is 100EC (212EF), its boiling point at standard atmospheric pressure.

Critical Aquifer Protection Area (CAPA) — As defined in the *Safe Drinking Water Act (SDWA)*, is all or part of an area located within an area for which an application of designation as a sole or principal source aquifer (pursuant to Section 1424[e]) has been submitted and approved by the Administrator not later than 24 months after the date of enactment and which satisfies the criteria established by the Administrator; and all or part of an area that is within an aquifer designated as a sole source aquifer (SSA), as of the date of the enactment of the Safe Drinking Water Act Amendments of 1986, and for which an areawide ground-water protection plan has been approved under Section 208 of the *Clean Water Act (CWA)* prior to such enactment.

Critical Area — An area that, because of its size, location, condition, or importance, must be treated with special consideration because of inherent site factors and difficulty of management. Also, a severely eroded, sediment-producing area that requires special management to establish and maintain vegetation to stabilize the soil.

Critical (Groundwater) Area — An area that has certain groundwater problems, such as declining water levels due, for example, to the use of undergroundwater that approaches or exceeds the current recharge rate. These designated areas are usually limited in their development and use.

Critical Depth — The depth of water flowing in an open channel or conduit under conditions of critical flow at which specific energy is a minimum for a given discharge.

Critical Dry Period — As a general definition, describes a series of water-deficient years, usually a historical period, in which a full reservoir storage system at the beginning is drawn down to minimum storage at the end without any spill.

Critical Dry Year — A dry year in which the full commitments for a dependable water supply cannot be met and deficiencies are imposed on water deliveries.

Critical Flow — (1) The flow conditions at which the discharge is a maximum for a given specific energy, or at which the specific energy is a minimum for a given discharge. (2) In reference to Reynolds' critical velocities, the point at which the flow changes from streamline or non-turbulent to turbulent.

Critical Habitat — The area of land, water, and airspace required for normal needs and survival (e.g., forage, reproduction, or cover) of a plant or animal species.

Critical Low-Flow — Low flow conditions below which some standards (*Criteria*) do not apply. The impacts of permitted discharges are typically analyzed at critical low-flow.

Critical Point — (1) (Physics) The temperature and pressure at which the liquid and gaseous phases of a pure stable substance become identical. Also referred to as the *Critical State*. (2) (Water Quality) The location downstream from a waste discharge at which the dissolved oxygen of the water is at its lowest. Also referred to as the *Critical Reach*.

Critical Reach — The point in the receiving stream below a discharge point at which the lowest dissolved oxygen level is reached and recovery begins. Also referred to as the *Critical Point*.

Critical Slope — (1) That slope that will sustain a given discharge at uniform, *Critical Depth* in a given channel. (2) The slope of a channel or conduit that will produce a critical flow, or a change in the flow of water from laminar to turbulent.

Critical Temperature, Critical Pressure — For a particular pure substance, the temperature above which no liquid phase can exist, regardless of pressure. For water, this temperature is 705 degrees Fahrenheit, and the critical pressure (pressure exerted by steam in presence of liquid at the critical temperature) is 3,206 pounds per square inch.

Critical Velocity — Velocity at which a given discharge changes from tranquil to rapid flow; that velocity in open channels for which the specific energy (the sum of the depth and velocity head) is a minimum for a given discharge.

Crop Coefficient — The ratio of evapotranspiration occurring with a specific crop at a specific stage of growth to potential evapotranspiration at that time.

Crop Consumptive Use (Crop Requirement) — Often called *Evapotranspiration*. The amount of water used by vegetative growth of a given area by transpiration and that evaporated from adjacent soil or intercepted precipitation on the plant foliage in any specified time (acre-feet/acre).

Crop Irrigation Requirement — The amount of irrigation water in acre-feet per acre required by the crop; it is the difference between *Crop Consumptive Use*, or *Crop Requirement*, and the effective precipitation for plant growth. To this amount the following items, as applicable, are added: (1) irrigation applied prior to crop growth; (2) water required for leaching; (3) miscellaneous requirements of germination, frost protection, plant cooling, etc.; and (4) the decrease in soil moisture should be subtracted.

Crop Moisture Index (CMI) (Drought Index) — The CMI, as a derivative of the *Palmer Drought Severity Index (PDSI)*, uses a meteorological method to monitor week-to-week crop conditions. Differing from the PDSI, the CMI was designed to evaluate short-term moisture conditions across major crop-producing regions. It is based on the mean temperature and total precipitation for each week within a "climate division", as well as the CMI value from the previous week. The CMI is specifically designed to monitor short-term moisture conditions affecting a developing crop and is not a good long-term drought monitoring tool. The CMI was designed for areas in which mountain snowpack is a key element of water supply conditions. The index is based on snowpack, streamflow, precipitation and reservoir storage and is calculated uniquely for each water basin, which tends to limit interbasin and inter-regional index comparisons. Also see *Drought Indexes (Indices)*.

Crop Requirement — See *Crop Consumptive Use*.

Crop Rotation — A pattern of changing the crops grown in a specific field from year to year in order to control pests and maintain soil fertility.

Crop Subsidy — A price support paid to farmers by the government.

Cropland — Land currently tilled, including cropland harvested, land on which crops have failed, summer fallowed land, idle cropland, cropland planted in cover crops or soil improvement crops not harvested or pastured, rotation pasture, and cropland being prepared for crops, or newly seeded cropland. Cropland also includes land planted in vegetables and fruits, including those grown on farms for home use. All cultivated (tame) hay is included as cropland. Wild hay is excluded from cropland and included in pasture and range.

Cross Connection — (1) A physical connection through which a supply of potable water could become contaminated. May include any actual or potential connection between a drinking water system and an unapproved water supply or other source of contamination. (2) Any actual or potential connection between a drinking (potable) water system and an unapproved water supply or other source of contamination. For example, if you have a pump moving nonpotable water and hook into the groundwater system to supply water for the pump seal, a cross-connection or mixing between the two water systems can occur. This mixing may lead to contamination of the drinking water. Also see *Backsiphonage* and *Backflow*.

Crossover Point — Any point or points at which a potable water main makes contact or crosses over or under a nonpotable liquid conduit (sewer, nonpotable water supply).

Cross Section — A graph or plot of ground elevation across a stream valley or a portion of it, usually along a line perpendicular to the stream or direction of flow.

Cross-Sectional Analysis — (Statistics) Observations or characteristics of a variable analyzed without respect to variations due to time. Cross-sectional econometric models provide information on the behavior of a variable due to external factors. Contrast with *Time-Series Analysis*.

Crown Cover — The amount of *Canopy* provided by ranches and foliage of trees, shrubs, and herbs in a plant community.

Crud — (Sports) Heavy, sticky snow that is unsuitable for skiing.

Crust — See *Snow Crust*.

Cryolithology — The study of the nature, structure, and development of underground ice, especially in permafrost regions.

Cryology — (1) The scientific study of snow and ice. (2) The science of the physical aspects of snow, ice, hail, sleet, and other forms of water produced by temperatures below 0EC (32EF).

Cryophyte — (Ecology) An organism that lives or thrives at low temperatures. More specifically, a plant that grows on snow or ice.

Cryoscope — An instrument used to measure the freezing point of a liquid.

Crystalline Basement — The older, generally igneous and metamorphic foundation rocks of a continental mass.

Crystalline Rocks — Usually refers to igneous and metamorphic rocks as opposed to sedimentary rocks, but it may also refer to any rock consisting of minerals in an obvious crystalline state.

Cryptodepression (Lake) — Lake basin whose deep parts are below sea level.

Cryptomonads — A group of brown colored flagellate algae, very common in the phytoplankton.

Cryptophyte — Algae of variable pigment concentrations, with various other unusual features. Algae of the division *Cryptophyta*.

Cryptosporidial (Crypto) Oocyst — The hard shell in which the parasite, *Cryptosporidium parvum*, resides. This hard shell protects the parasite in the environment and remains viable for up to six months. This shell also protects the protozoa from chlorine disinfection treatment.

Cryptosporidiosis — A disease of the intestinal tract caused by the parasite *Cryptosporidium parvum*. Common symptoms include stomach cramps and diarrhea.

Cryptosporidium — Microscopic organisms that, when ingested, can result in diarrhea, fever and other gastrointestinal symptoms. They are naturally present in bodies of water throughout the world. Also see *Cryptosporidium Parvum*.

Cryptosporidium Parvum — A parasite often found in the intestines of livestock which contaminates water when the animal feces interact with a water source. Literally, cryptosporidium means “mystery spore,” and the parasite was not recognized as a human pathogen until 1976. In healthy individuals, infection may result in an acute diarrheal illness lasting for 2-3 weeks. In immunosuppressed individuals (e.g., AIDS patients, children, elderly), *Cryptosporidiosis*, the disease from infection by the parasite, may be life-threatening. While much needs to be learned about the infectious level of crypto, studies have indicated that it takes five to ten cysts to make someone sick. Of particular concern to health officials and public drinking water supplies is that the most widely used agent to disinfect tap water – chlorine – does not kill the parasite. Also, the laboratory tests used to detect crypto are time-consuming, laborious, and expensive. As an additional complication in the detection process, there are several varieties of crypto, but only one – *Cryptosporidium parvum* – is infectious to humans. Also, laboratory tests cannot determine whether a *Crypto Oocyst*, the hard shell that protects the protozoa, is alive or dead. Currently, the only effective treatment for water supplies is through filtration (crypto oocysts are only 3 to 7 microns in size) and the use of ozone gas rather than chlorine. As of January 1997, the U.S. Environmental Protection Agency (EPA), through the Information Collection Rule (ICR), has required that all public water supply systems serving more than 100,000 connections to monitor for cryptosporidium.

Crystalline Frost — A hoarfrost exhibiting a simple macroscopic crystalline structure.

Crystosphere — A mass or sheet of clear ice buried and wedged between beds of other material, such as frozen spring water that rises and spreads laterally under swamps in a tundra region.

CSO — See *Combined Sewer Overflow*.

CT or CT calc — The product of “residual disinfectant concentration” (“C”) in mg/L determined before or at the first customer, and the corresponding “disinfectant contact time” (“T”) in minutes, i.e., “C” x “T”. If a public water system applies disinfectants at more than one point prior to the first customer, it must determine the CT of each disinfectant sequence before or at the first customer to determine the total percent inactivation or “total inactivation ratio”. In determining the total inactivation ratio, the public water system must determine the residual disinfectant concentration of each disinfection sequence and corresponding contact time before any subsequent disinfection application point(s). The term “CT99.9” is the CT value required for 99.9 percent (3-log) inactivation of *Giardia lamblia* cysts.

CT99.9 — A variety of disinfectants and conditions which appear in Tables 1.1 – 1.6, Table 2.1, and Table 3.1 of Section 141.74(b)(3) in the Code of Federal Regulations. “CT99.9” is the inactivation ratio. The sum of the inactivation ratios, or total inactivation ratio shown as

$$E = (CT \text{ calc}) / (CT99.9)$$

is calculated by adding together the inactivation ratio for each disinfection sequence. A total inactivation ratio equal to or greater than 1.0 is assumed to provide a 3-log inactivation of *Giardia lamblia* cysts. See *CT or CTcalc*.

Cubic Feet Per Second (CFS) — A unit expressing rate of discharge, typically used in measuring streamflow in the English system. One cubic foot per second, or “cusec”, is equal to the discharge of a stream having a cross section of one square foot and flowing at an average velocity of one foot per second. It also equals a rate of approximately 7.48 gallons per second, 448.83 gallons per minute, 1.9835 acre-feet per day, or 723.97 acre-feet per year (or 724.47 acre-feet per year for years of 365.25 days for longer-

term flow analysis).

Cubic Feet Per Second Day (CFS-Day) — The volume of water represented by a flow of one cubic foot per second for 24 hours. It equals 86,400 cubic feet, 1.983471 acre-feet, or 646,317 gallons.

Cubic Feet per Second per Square Mile (CFSM, (ft³/s)mi²) — The average number of cubic feet of water flowing per second from each square mile of area drained, assuming the runoff is distributed uniformly in time and area.

Cucking Stool — A chair formerly used for punishing offenders (as dishonest tradesmen) by public exposure or ducking in water.

Cultivate — To break up the soil surface, often removing weeds at the same time.

Cultural Eutrophication — (Ecology) (1) The increasing rate at which water bodies “die” by pollution from human activities. (2) Over nourishment of aquatic ecosystems with plant nutrients (mostly nitrates and phosphates) because of human activities such as agriculture, urbanization, and discharges from industrial plants and sewage treatment plants.

Cultural Landscape — Man-made features of a region reflecting land-use patterns, population distribution, and other activities of man that have altered the natural landscape.

Culvert — A transverse drain or waterway under a road, railroad, canal, or other obstruction.

Culvert Dam — When culverts are constructed under roads that cross over the effluent (outlet) stream of a lake, they may be laid at a higher level than the original stream bed. When installed in this fashion, they act as low head dams and may raise the level of the entire lake. The culvert acts as an outlet when the water rises to its level.

Cumatophyte — (Ecology) A plant that lives or thrives in surf conditions. Also referred to as *Cumaphyte*.

Cumulative Exposure — The summation of exposures of an organism to a chemical over a period of time.

Cumulative Impact — The environmental impacts of a proposed action in combination with the impacts of other past, existing and proposed actions. Each increment from each action may not be noticeable but cumulative impacts may be noticeable when all increments are considered together.

Cumulative Infiltration — The summation of the depth of water absorbed by a soil in a specified elapsed time in reference to the time of initial water application.

Cumulonimbus Clouds — A principal cloud type; the ultimate stage of development of *Cumulus* clouds. Cumulonimbus clouds are very dense and very tall, commonly 5 to 10 miles in diameter, and sometimes reaching heights of 12 miles or more. The upper portion is at least partly composed of ice crystals, and it often takes the form of an anvil or vast plume. The base of the cloud is invariably dark and is often accompanied by low, ragged clouds. Also commonly called *Thundercloud*, *Thunderhead*, *Thunderstorm*. Also see *Cloud*.

Cumulus Clouds — (1) A principal cloud type characterized by vertical development; usually isolated with a dark, nearly horizontal base and upper parts resembling domes or towers and usually formed by the ascent of thermally unstable air masses. (2) (2) Very dense, white clouds of vertical development with gray flattened bases and dome-shaped tops. Continued development leads to *Cumulus Congestus* then *Cumulonimbus*. Also see *Cloud*.

Cumulus Congestus — A large, towering cumulus cloud with great vertical development, usually with a cauliflower-like appearance, but lacking the characteristic anvil of a *Cumulonimbus*.

Cunette — A longitudinal channel constructed along the center and lowest part of a channel or through a detention or retention facility and intended to carry low flows. Also referred to as a *Trickle Channel*.

Cup Crystal — A form of depth hoar having the shape of a hollow hexagonal cup with stepped surfaces.

Curb Stop — A water service shutoff valve located in a water service pipe near the curb and between the water main and the building. This valve is usually operated by a wrench or valve key and is used to start or stop flows in the water service line to a building. Also called a “curb cock”.

Curie — A measure of radioactivity. One Curie of radioactivity is equivalent to 3.7×10^{10} or 37,000,000,000 nuclear disintegrations per second.

Curl — A hollow arch of water formed when the crest of a breaking wave spills forward.

Curler — A high steep wave that curls or falls back onto its own upstream face. Considered by most to be a form of *Reversal*.

Current — (1) A horizontal movement of water in a well-defined, established pattern, as in a river or stream. (2) The portion of a stream or body of water which is moving with a velocity much greater than the average of the rest of the water. The progress of the water is principally concentrated in the current. (3) The swiftest part of a stream; (4) A tidal or nontidal movement of lake or ocean water; (4) Flow marked by force or strength. Also see *Ocean Current*.

Current (Measurement) — (1) (Water) A movement or flow of water. Water flowing in a pipe is measured in gallons per second (gal/sec) or for a river in cubic feet per second (cfs) past a certain point. (2) (Electricity) Electric current is measured by the number of coulombs per second flowing past a certain point in a conductor. A coulomb is equal to about 6.25×10^{18} electrons (6,250,000,000,000,000,000 electrons). A flow of one coulomb per second is called one ampere, the unit of the rate of flow of current.

Current Drift — A shallow, broad, slow-moving current in a lake or ocean.

Current Meter — An instrument for measuring the velocity of water flowing in a stream, open channel, or conduit by ascertaining the speed at which elements of the flowing water rotate a vane or series of cups.

Curtailment Pricing — Pricing water at a rate to reduce consumption.

Cusp (Beach) — Triangular deposit of sand, or other current drift, spaced along a shore. Size and configuration is apparently controlled by the magnitude and direction of wave action or current forces. Cusps are transient under some conditions, formed by storm waves and erased by a succeeding storm, but under other conditions are fairly long and relatively permanent features.

Cuspate Foreland — Formation consisting of a V-bar and a *Foreland* created from the joining of two spits in a lake. The space between the enclosing sides may be water; or the foreland may be a complex of beach deposits which are cusped in form.

Cut and Built Terrace — See *Wave Built Terrace* or *Littoral Shelf*.

Cutback Irrigation — Water applied at a faster rate at the beginning of the irrigation period and then reduced or cutback to a lesser rate, usually one-half the initial rate or that amount to balance with the intake rate.

Cut Bank — The outside bank of a bend, often eroding opposite a point bar.

Cutoff (also Cut Off) — (1) The new and relatively short channel or body of water created when a stream cuts through the neck of an *Oxbow*. (2) (Hydraulics) The new and shorter channel formed either naturally or artificially when a stream cuts through the neck of a bank or oxbow; a channel cut across the neck of a bend. (3) (Geology) A boundary line indicating the areal limit of a stratigraphic unit that is not defined by natural features. (4) (Dam) An impervious construction or material which reduces seepage or prevents it from passing through the foundation material of a dam structure.

Cutoff Trench (of a Dam) — An excavation later to be filled with impervious material to form a *Cutoff*. Sometimes used incorrectly to describe the cutoff itself.

Cutoff Wall (of a Dam) — A wall of impervious material (e.g., concrete, asphaltic concrete, steel sheet piling) built into the foundation of a dam to reduce or prevent seepage under the dam.

Cutwater — (1) (Nautical) The forward part of a ship's prow. (2) The wedge-shaped end of a bridge pier, designed to divide the current and break up ice floes.

CWS — See *Community Water System*.

Cyanazine — A herbicide listed by the U.S. Environmental Protection Agency (EPA) as a "possible human carcinogen" and found frequently in streams and rivers, particularly following floods and periods of heavy rain and runoff from agricultural lands. Cyanazine is used extensively for weed control for corn, sorghum, and sugarcane. Along with another common farm herbicide, *Atrazine*, Cyanazine concentrations can soar to levels much higher than federal standards during the peak growing season.

Cyanide — (Wastewater Treatment) The cyanide ion (CN⁻) consists of carbon (C) and nitrogen (N). Cyanide is commonly found in metal plating wastewaters because most metal cyanides are soluble and plating occurs readily from cyanide solutions. The cyanide ion is extremely toxic and must be removed from metal wastes before discharge to the environment. Treatment of wastes containing cyanide under acidic conditions may produce extremely toxic gases which must never come in contact with people or animals.

Cyanobacteria — See *Blue-Green Algae*.

Cyanophyte — Blue green algae, algae of the division *Cyanophyta* actually a set of pigmented bacteria.

Cycle — (Statistics) A periodic, repetitive fluctuation in time series data from either a constant mean or trend line. Typically, the oscillations of a cycle will be greater than one year in length. Cycles within a year are termed *Seasonality*.

Cycle of Erosion — A qualitative description of river valleys and regions passing through the stages of youth, maturity, and old age with respect to the amount of erosion that has been effected.

Cycle of Fluctuation — See *Phreatic Cycle*.

Cycle of Sedimentation — (Geology) (1) The ordered, recurring sequence of related processes and conditions recorded in sedimentary deposits. Also referred to as *Sedimentary Cycle*. (2) The deposition of sediments in a basin by the recurring changes of water levels. Also see *Cyclothem*.

Cyclic Salt — (Oceanography) A salt that is introduced into the atmosphere from the sea surface by evaporation and bursting bubbles, blown inland, and then returned to the sea by normal drainage processes.

Cyclone — (Meteorology) An atmospheric system characterized by the rapid, inward circulation of air masses about a low-pressure center, usually accompanied by stormy, often destructive, weather. Cyclones circulate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Also see *Typhoon* and *Coriolis Effect*.

Cyclonic Precipitation — Precipitation which results from the lifting of air converging into a low-pressure area, or *Cyclone*.

Cyclonic Storm — A rain or snow event that results from air that is forced to rise over (1) a wedge of cold air that is slipping beneath it (cold front), or (2) a wedge of warmer air that is overriding (warm front).

Cyclothem — See *Cycle of Sedimentation*.

Cypress Knees — Part of a cypress tree's root system that juts out of the ground, extending above the high water mark.

Cypress Ponds — Ponds or lakes characterized by growths of cypress (*Taxodium spp.*).

Cypress Swamp — A wetland environment common throughout the southeastern United States in which cypress trees are a dominant species.

Cypriere — In Louisiana, a *Cypress Swamp*. Cypress swamps generally are permanently water covered areas.

D

D-Horizon — (Geology) A former term for the layer of soil lying beneath the *B-Horizon* or the *C-Horizon*, consisting of unweathered rock.

Dabble — To bob forward and under in shallow water so as to feed off the bottom.

Daily Flood Peak — The maximum mean daily discharge occurring in a stream during a given flood event.

Daily Record — A summary of streamflow, sediment, or water-quality values computed from data collected with sufficient frequency to obtain reliable estimates of daily mean values.

Daily Record Station — A site for which daily records of streamflow, sediment, or water-quality values are computed.

Daily Retardation — (Oceanography) The amount of time by which corresponding tides occur later each day (about 50 minutes on average).

Daily Temperature Range — The difference between the highest and lowest temperatures recorded on a particular day.

Dalton — A unit of molecular weight; a unit of mass convenient for the expression of the mass of atoms, being one-sixteenth the mass of an oxygen atom. It equals approximately 1.65×10^{-24} grams. Named after the English chemist and physicist John Dalton (1766-1844). Used frequently for sizing particles trapped by semipermeable membrane filters.

Dam — (1) An artificial barrier, including appurtenant works, which impounds or diverts water. (2) A structure of earth, rock, or concrete designed to form a basin and hold water back to make a pond, lake, or reservoir. A barrier built, usually across a watercourse, for impounding or diverting the flow of water. (3) (Sample Legal Definition) An artificial barrier, including appurtenant works, which impounds or diverts water and which is a specified height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier, if it is not across a stream channel or watercourse, to the maximum water storage elevation or has an impounding capacity at maximum water storage elevation of a minimum specified volume in acre-feet. A barrier may not be considered a dam for the purpose of this definition if the height does not exceed a minimum height regardless of storage capacity, or if the storage capacity at maximum water storage elevation does not exceed a specified volume in acre-feet, regardless of height. General types of dams include:

- [1] **Arch Dam** — Curved masonry or concrete dam, convex in shape upstream, that depends on arch action for its stability; the load or water pressure is transferred by the arch to the *Abutments*.
- [2] **Buttress Dam** — A dam consisting of a watertight upstream face supported at intervals on the downstream side by a series of buttresses.
- [3] **Cofferdam** — A temporary watertight enclosure that is pumped dry to expose the bottom of a body of water so that construction, as of piers, a dam, and bridge footings, may be undertaken. A “diversion cofferdam” prevents all downstream flow by diverting the flow of a river into a pipe, channel, or tunnel.
- [4] **Crib Dam** — A barrier or form of *Gravity Dam* constructed of timber forming bays, boxes, cribs, crossed timbers, gabions or cells that are filled with earth, stone or heavy material.
- [5] **Embankment Dam** — A dam structure constructed of fill material, usually earth or rock, placed with sloping sides and usually with a length greater than its height. Types of embankment dams include: *Earthfill or Earth Dam* — A dam in which more than 50 percent of the total volume is formed of compacted fine-grained material obtained from a borrow area (i.e., excavation pit); *Fill Dam* — Any dam constructed of excavated natural materials or of industrial waste materials; *Homogeneous Earthfill Dam* — A dam constructed of similar earth material throughout, except for the possible inclusion of internal drains or drainage blankets; distinguished from a *Zoned Earthfill Dam*; *Hydraulic Fill Dam* — A dam constructed of materials, often dredged, that are conveyed and placed by suspension in flowing water; *Rockfill Dam* — A dam in which more than 50 percent of the total volume is comprised of compacted or dumped pervious natural or crushed rock; *Rolled Fill Dam* — A dam of earth or rock in which the material is placed in layers and compacted by using rollers or rolling equipment; and *Zoned Embankment Dam* — A dam which is composed of zones of selected materials having different degrees of porosity, permeability, and density.
- [6] **Gravity Dam** — A dam constructed of concrete and/or masonry that relies on its weight for stability.
- [7] **Inflatable Dam** — A dam constructed of heavy-duty rubber or similar material and inflated with air or water and used for small-scale impoundment of flood flows or as flash boards for regulating the overflow of larger dams.
- [8] **Masonry Dam** — A dam constructed mainly of stone, brick, or concrete blocks that may or may not be joined with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.
- [9] **Weir** — A dam in a river to stop and raise the water, for the purpose of conducting it to a mill, forming a fishpond, or the like. When uncontrolled, the weir is termed a fixed-crest weir. Other types of weirs include broad-crested, sharp-crested, drowned, and submerged.

Also see *Dams (Risk Categories)*.

Dam Failure — Catastrophic event characterized by the sudden, rapid, and uncontrolled release of impounded water.

Damage-Frequency Curve — A graph showing the flood damages and their probabilities of occurrence. The total area under the curve represents the annual damage.

Damages Prevented — The difference between the amount of damages without a particular water project and the damages with the project in place.

Damp — Slightly wet; somewhat moist or wet.

Dams (Risk Categories) — (Examples) Frequently dam structures are rated according to their risk to human loss of life and property damages. The following represents a sampling of risk categories used by some states:

- [1] **Category 1 Dam** — A high hazard dam whose failure may cause loss of life.
- [2] **Category 2 Dam** — A significant hazard dam whose failure may cause damage to buildings, highways, railroads, bridges, or public utilities; loss of a water supply reservoir for a water distribution system; other extensive economic loss; or the reservoir is the only source of water for a water distribution system.
- [3] **Category 3 Dam** — A low hazard dam whose failure may cause limited damage to agricultural lands or county and township roads or minimum economic loss.

Dap — (1) To dip lightly or quickly into water, as a bird does. (2) To skip or bounce, especially over the surface of water.

Darcy's Law — (1) The equation for the velocity of flow of which states that in material of given permeability, velocity of flow increases as the slope of the table increases. (2) An empirically derived equation for the flow of fluids through porous media. It is based on the assumption that flow is laminar and inertia can be neglected, and states that velocity of flow is directly proportional to *Hydraulic Gradient*. For groundwater, this is equivalent to the velocity being equal to the product of the hydraulic gradient and the effective subsoil conductivity or permeability. See *Specific Discharge (Specific Flux)*.

Data — In its strictest sense, data may be defined only as the raw numbers (or descriptions, in the case of qualitative data), either in *Time-Series* format (data covering observations over specific periods of time), *Cross-Sectional* format (data consisting of a number of observations taken at a specific point in time or about a specific event or phenomenon), or a combination of these two. Also see *Information*.

Data Bank — A well-defined collection of data, usually of the same general type, which can be accessed by a computer and may readily be used for further analysis, presentation, and forecasting. Also referred to as a *Data Base*.

Data, Cross-Sectional — (Statistics) Data which describe the activities or behavior of individual persons, firms, or other units at a given point in time.

Data Management — The act, process, or means by which data is managed. This may include the compilation, storage, safeguarding, listing, organization, extraction, retrieval, manipulation, and dissemination of data. In its strictest sense, data may be defined only as the raw numbers for numeric or quantitative data (or descriptions, in the case of qualitative data), either in time-series format (data covering observations over specific periods of time), cross-sectional format (data consisting of a number of observations taken at a specific point in time or about a specific event or phenomenon without regard to its behavior over time), or a combination of these two. Information, on the other hand, deals more specifically with the manipulation, re-organization, analysis, graphing, charting, and presentation of data for specific management and decision-making purposes. Also see *Information Management*.

Data, Primary — Typically, data acquired by direct interaction, such as direct observation through measurements, tabulation, or surveys. Contrast with *Secondary Data*.

Data, Secondary — Typically, data acquired from published sources as opposed to data acquired from direct observation or measurement such as a survey. Contrast with *Primary Data*.

Data, Time-Series — (Statistics) Data which describe the movement of a variable over time, e.g., monthly, quarterly, annually.

Datum — Any numerical or geometric quantity or set of such quantities that may serve as a reference or base for other, comparable quantities. For example, *Mean Sea Level (MSL)* is the datum used on most topographic maps. However, most river gages use an arbitrary elevation above the *National Geodetic Vertical Datum (NGVD)* of 1929 for use as a zero datum (e.g., datum equals 3412.6 feet above NGVD of 1929). Datums are always chosen so there will never be negative stages.

Daylight — In the restoration field, a verb that denotes the excavation and restoration of a stream channel from an underground culvert, covering, or pipe.

Day Tank — A tank used to store a chemical solution of known concentration for feed to a chemical feeder. A day tank usually stores sufficient chemical solution to properly treat the water being treated for at least one day. Also called an age tank.

DBCP — See *Dibromochloropropane*.

DBP — Disinfectant By-Product.

DDBP — Disinfectants and Disinfectant By-Products.

DDT (Dichlorodiphenyltrichloroethane) — A colorless odorless water-insoluble crystalline insecticide $C_{14}H_9Cl_5$ that tends to accumulate in ecosystems and has toxic effects on many vertebrates. DDT was a widely used colorless contact insecticide, discovered in 1939 and first used commercially in 1945. DDT remains active in the environment for years, passing from the air and water to plants, animals, and humans. DDT was used extensively prior to 1972 at which time the *U.S. Environmental Protection Agency (EPA)* banned its production and distribution. Although banned from usage for a number of years, the inert nature of such toxic chemicals and their low biodegradability (15-year half-life) allow them to exist in soils, river sediment, and plants and animals for many years.

De Minimis — Derived from the Latin meaning that the law does not care for or take notice of very small or trifling matters. De minimis water uses are those deemed by law to be too insignificant to notice.

Dead End — The end of a water main which is not connected to other parts of the distribution system by means of a connecting loop of pipe.

Dead Lake — A dried-up lake that has been filled in by vegetation.

Dead Sea — Any body of water from which sedimentary salts have been or are being precipitated.

Dead Storage — (1) The volume of water in a reservoir stored below the lowest outlet or operating level. (2) The volume in a reservoir below the lowest controllable level. (3) Storage in a reservoir that cannot be released by the dam.

Dead Time — The time required for the response to a change of input to a system to reach the location of a sensor (i.e., the time for a control initiated surge wave to travel from an upstream control check gate to a downstream sensor in a canal.)

Dead Water — (Oceanography) Sea water in which a thin layer of fresher water overlies a layer of more saline water.

Dead Zone [Gulf of Mexico] — (Ecology) A term referring to an extensive area, recorded to be as large as 7,000 square miles [July 1995], that develops every summer at the bottom of the Gulf of Mexico. The area consists of a lifeless area devoid of oxygen that results from an ecological chain reaction precipitated by fertilizers, sewage, and runoff that flows from the Mississippi River. While many sources contribute to this phenomenon, the primary nutrient cause consists of fertilizer runoff from agriculture within the Mississippi River Basin.

Deadman — A log, block of concrete, rebar, or other object buried in a stream bank that is used to tie in a revetment with cable or chain.

Debacle — (1) The breaking up of ice in a river. (2) A violent flood.

Debouch — To emerge; issue, as a river into which a large stream debouches.

Debouchure — An opening or mouth, as of a river or stream.

Debris — Accumulated material; any material, including floating or submerged trash, suspended sediment, or bed load, moved by a flowing stream.

Debris Basins — Storage for sediment and floating material provided by a dam with spillway above channel grade, by excavation below grade, or both. Water retention is not an intended function of the structure.

Debris Cloud — A rotating “cloud” of dust or debris, near or on the ground, often appearing beneath a funnel cloud and surrounding the base of a tornado. The presence of a debris cloud confirms the existence of a *Tornado*.

Debris Cone — On a *Glacier*, a mound of ice or snow covered by a thin layer of debris that protects the underlying material from ablation. Also referred to as a *Glacial Cone*. Geology. Also see *Alluvial Cone*.

Debris Dam — A barrier built across a stream channel to retain rock, sand, gravel, silt, or other material.

Debris Flood — A flood that is intermediate between the turbid flood of a mountain stream and a true mudflow.

Debris Flow — (1) A moving mass of rock fragments, soil, and mud with more than one-half of the material being larger than sand size. (2) The rapid downslope plastic flow of a mass of debris. A mass movement involving rapid flowage of debris of various kinds under various conditions; specifically, a high-density *Mudflow* containing abundant coarse-grained materials and resulting almost invariably from an unusually heavy rain. (3) The rapid mass movement of a dense, viscous mixture of rock fragments, fine earth, water and entrapped air that almost always follows a heavy rain. A mudflow is a debris flow that has predominately sand size or smaller particles.

Debris Glacier — A *Glacier* formed from ice fragments of a taller glacier.

Debris Guard — A screen or grate at the intake of a channel, drainage, or pump structure for the purpose of stopping debris.

Debris Ice — Sea ice that contains mud, soil, shells, stones, and other material. Also see *Brash Ice*.

Decant — To draw off the upper layer of liquid after the heaviest material (a solid or other liquid) has settled.

Decay — The disintegration of organic materials into simpler forms, or into their original elements, by action of bacteria, fungi, or other microorganisms.

Dechlorinate — To remove *Chlorine* from water.

Dechlorination — (1) The deliberate removal of chlorine from water. The partial or complete reduction of residual chlorine by any chemical or physical process. (2) The partial or complete reduction of residual chlorine in a liquid by any chemical or physical process. Commonly used dechlorinating agents include activated carbon and sulfur dioxide.

Deciduous (Plant) — (Botanical) (1) Any plant that sheds all of its leaves at one time each year (typically in autumn). (2) Plants characterized by a specific growth and dormancy cycle, with certain parts falling at the end of the growing period, as leaves, fruits, etc., or after anthesis, as the petals of many flowers. (2) Plants having leaves of this type. As contrasted with *Evergreen* which remains verdant throughout the year.

Deciduous Stand — A plant community where *Deciduous* trees or shrubs represent more than 50 percent of the total areal coverage of trees or shrubs.

Deciles (Drought Index) — The deciles drought index system is based on a relative frequency distribution of long-term precipitation divided into tenths of the overall range of distribution. Each tenth division or precipitation category is termed a “decile” and ranges from the lowest (drought) ten percentile of precipitation levels to the highest (wet) ten percentile. By definition, the fifth decile is the median (middle-most) and is the precipitation amount not exceeded by 50 percent of the occurrences over the period of record. One disadvantage of the deciles drought index system is that a long climatological record is required for accurate deciles classifications. As a drought index, the deciles are grouped into five classifications as shown in the follow table:

Deciles Classifications	Drought Condition
Deciles 1-2 (lowest 20%)	Much below normal
Deciles 3-4 (next lowest 20%)	Below normal
Deciles 5-6 (middle 20%)	Near normal

Deciles 7-8 (next highest 20%)	Above normal
Deciles 9-10 (highest 20%)	Much above normal

Also see *Drought Indexes (Indices)*.

Declared Underground Water Basin — An area of a state designated in some states by their respective State Engineers to be underlain by a source having reasonably ascertainable boundaries. By such a designation, the State Engineer assumes jurisdiction over the appropriation and use of from the source. May not be applicable in states which already claim regulatory rights over both surface and groundwaters.

Decomposer — Any of various organisms (as many bacteria and fungi) that feed on and break down organic substances (such as dead plants and animals).

Decomposition — (1) The breakdown of matter by bacteria and fungi, changing the chemical makeup and physical appearance of materials. (2) The conversion of chemically unstable materials to more stable forms by chemical or biological action. If organic matter decays when there is no oxygen present (anaerobic conditions or putrefaction), undesirable tastes and odors are produced. Decay of organic matter when oxygen is present (aerobic conditions) tends to produce much less objectionable tastes and odors.

Decorative Water Feature — Any manmade stream, fountain, waterfall, or other such water feature that contains water that flows or is sprayed into the air, constructed for decorative, scenic, or landscape purposes.

Decree — The judgement of a court, an official order, or settlement.

Decree 731 (Interim Walker River Decree) [Nevada] — In response to the suit filed in 1902 (*Miller et Lux v. Rickey*), subsequently renamed to the *Pacific Livestock Company v. Antelope Valley Land and Cattle Company*, water rights adjudication in the Federal District Court for Nevada resulted in the issuance of Decree 731 on March 24, 1919. [During the Nevada gold mining boom of the early 1900's, Thomas B. Rickey was actively involved in both mining and banking as well as ranching. So much so, in fact, that he suffered failure in the panic of 1907 and his ranching properties were sold to the Antelope Valley Land and Cattle Company. Also, the agricultural holdings of Muller and Lux were taken over by the Pacific Livestock Company.] The Decree addressed the amount of water to which each party was entitled, the source of the water, the area to which it was to be applied, and the priority date for each use. The Decree also encompassed many, but not all, of the other water users on the river, particularly the water rights of the smaller agricultural water users as well as the irrigation rights of the Walker River Indian Reservation. Five separate water rights for the reservation were quantified with priority dates ranging from 1868 to 1886 (the reservation was established on November 29, 1859) and the government was permitted to purchase additional rights from the proposed Topaz Reservoir to supply the reservation. [These five water rights included: (1) 1868 priority date – 4.70 cfs, 385.95 acres irrigated; (2) 1872 priority date – 3.55 cfs, 295.80 acres irrigated; (3) 1875 priority date – 6.15 cfs, 512.80 acres irrigated; (4) 1883 priority date – 7.50 cfs, 625.20 acres irrigated; and (5) 1886 priority date – 1.03 cfs, 85.80 acres irrigated.] In effect, the Decree addressed essentially only direct diversions from the river and its tributaries. Except for some general provisions pertaining to the Antelope Valley Land and Cattle Company's storage rights, particularly those relating to the prospective development of Alkali Lake (Topaz) Reservoir, no other storage rights were quantified. As an interim measure, Decree 731 did assign priorities and amounts of water for irrigating specified lands of the parties and allowed incidental domestic and stock-watering uses to be served under the irrigation rights.

Decree C-125 (Final Walker River Decree) [Nevada] — In adjudication of the 1924 filing of *United States v. Walker River Irrigation District, et al.*, Decree C-125 for waters of the Walker River was issued on April 14, 1936 by the Federal District Court for Nevada. In addition to recognizing the water rights defined in Decree 731 (March 24, 1919) as to priority date, amount and place of use, and defined other storage and diversion rights, the Walker River Indian Reservation's attempt to acquire a right to divert 150 cfs for the irrigation of reservation lands was rejected. While Decree C-125 adjudicated most of the irrigation rights of the Walker River system, the court did not define domestic rights, irrigation uses on natural forest land, some private riparian lands, and any storage rights for Weber Reservoir, which had recently been constructed on the Walker River Indian Reservation. Also, no rights were included for Walker Lake itself. A federal *Watermaster* would be responsible for its enforcement. The District Court refused the Tribe's claim (for right to a rate of flow of 150 cfs), stating that even if an implied tribal water right was included with reservation lands, the white pioneers were in "an inexpugnable position" and the "court was not about to take fifty years of beneficial farming use away from these settlers for the sake of supplying the tribe with guaranteed water." In June 1939 Decree C-125 was modified on appeal to the U.S. Circuit Court of Appeals, Ninth Circuit (104 Fed 2d 334 [1939]). The Walker River Indian Reservation was granted a right to divert 26.25 cfs (they had asked for 150 cfs) for 180 days (amounting to 9,450 acre-feet from natural flows) to be measured at the Parker Gage (currently the Wabuska gage) at the north (outlet) end of Mason Valley approximately where the reservation boundary begins. This diversion period is in contrast to upstream users who have an irrigation season of up to 245 days as reaffirmed in the "Rules and Regulations for the Walker River System" under Decree C-125. All defendants agreed to the stipulation which granted the Walker River Indian Reservation a November 29, 1859 priority date for its water rights for the irrigation of 2,100 acres of reservation land. The original priority dates established in Decree 731 in 1919 had assigned priority dates (5) ranging from 1868 to 1886. [These five water rights included: (1) 1868 priority date – 4.70 cfs, 385.95 acres irrigated; (2) 1872 priority date – 3.55 cfs, 295.80 acres irrigated; (3) 1875 priority date – 6.15 cfs, 512.80 acres irrigated; (4) 1883 priority date – 7.50 cfs, 625.20 acres irrigated; and (5) 1886 priority date – 1.03 cfs, 85.80 acres irrigated.]

Decreed Rights (Water) — Water rights determined by court decree.

Decrement — See *Groundwater Discharge*.

Dedicated Natural Flow — River flows dedicated to environmental use. Also see *Environmental Flows*.

Dedications (Water) — A controversial water rights policy that involves a trade-off in which a user can begin pumping groundwater

in exchange for a guarantee to buy and retire a like amount of surface water in the future. Critics of the policy argue that dedications are often difficult to enforce and can lead to overuse of groundwater when a user fails to fulfill on the guarantee.

Deep Carbonate Aquifer [Nevada] — An aquifer within the *Great Basin* which is comprised of a thick sequence of carbonate rock, generally lying below basin fill deposits.

Deep-Draft Harbor — A harbor designed to accommodate commercial cargo vessels having drafts greater than 15 feet (4.6 meters).

Deep-Lava Theory — (Geophysics and Climatology) A theory first espoused by a geophysicist from the University of Hawaii whose research found a strong *Correlation* between periodic patterns of undersea volcanoes (and related seismic activity) within what is known as the East Pacific Rise and the onset of *El Niño*, a phenomenon characterized by a warming of surface waters in the eastern Pacific Ocean near the Equator. While the causes surrounding the arrival of the El Niño effect are complex and not fully understood, it is generally recognized that the event is accompanied by a stall in the trade winds that normally blow from west to east across the southern Pacific. The Deep-Lava Theory postulates that heated seawater (from increased undersea lava flow activity) weakens a normally high-pressure area in the eastern Pacific. This, in turn, reduces air pressure and slows the trade winds. Subsequently, warm water in the western Pacific is released, along with warm unstable air above it, by the absence of the trade winds, thereby producing the El Niño effect along the western coast of South America, along with changes to other weather patterns elsewhere. For example, also see *Hurricane Forecasting*.

Deep Percolation (Loss) — (1) Water that percolates downward through the soil beyond the reach of plant roots. (2) Water that percolates below the lower limit of the *Root Zone* of plants into an aquifer and cannot be used by plants. (3) The percolation of surface water through the ground beyond the lower limit of the root zone of plants into a *Groundwater Aquifer*. (4) Percolation of (irrigation) water through the ground and beyond the lower limit of the root zone of plants into groundwater.

Deep-Sea Basin — (Geology) A more or less equidimensional depression in the ocean floor that varies in extent.

Deep-Sea Channel — (Geology) A trough-shaped, low-relief valley located on the deep-ocean floor beyond the continental rise.

Deep-Sea Plain — (Geology) A broad, almost flat area that forms most of the ocean floor.

Deep-Sea Trench — (1) Trench a narrow, steep-sided depression eroded by a stream. (2) (Geology) A steep-sided, elongated depression in the deep-sea floor, occurring between the continental margin and the abyssal hills. Also referred to as *Deep-Sea Trench*, *Oceanic Trench*, or *Sea-Floor Trench*.

Deep Seepage (Losses) — (1) Infiltration which reaches the *Water Table*. (2) That portion of applied irrigation water that, in excess of the *Leaching Requirement*, passes through the rooting zone and is subsequently unavailable for crop use.

Deep Water — (Oceanography) (1) Water deep enough that surface waves are not affected by conditions on the bottom. (2) Water masses that originated in polar regions but that are now found in the deepest regions of the ocean, generally below 3 kilometers (10,000 feet) in depth.

Deep-Water (also Deepwater) — (Prefix) (1) Of, relating to, or carried on in waters of a relatively great depth, for example, a deep-water port or a deep-water drilling for oil. (2) Of, relating to, or characterized by water of considerable depth, especially water able to accommodate oceangoing vessels.

Deep Well — A well whose pumping head is too great to permit use of a suction pump.

Deep-Well Disposal — Transfer of liquid wastewater to underground strata; usually limited to biologically or chemically stable wastes.

Deep-Well Injection — Deposition of raw or treated, filtered hazardous waste by pumping it into deep wells, where it is contained in the pores of permeable subsurface rock.

Deepwater Habitats — (Ecology) In conjunction with *Wetlands*, *Deepwater Habitats* constitute the spectrum of an ecological classification system to better understand and describe the characteristics and values of all types of land and to wisely and effectively manage such ecosystems. Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium within which the dominant organisms live, whether or not they are attached to the substrate. As in wetlands, the dominant plants are hydrophytes; however, the substrates are considered nonsoil because the water is too deep to support emergent vegetation. While wetlands and deepwater habitats are defined separately, both must be considered in an ecological approach to classification. The deepwater habitat/wetland classification includes five major systems:

- [1] *Marine*
- [2] *Estuarine*
- [3] *Riverine*
- [4] *Lacustrine*
- [5] *Palustrine*

The first four of these classifications include both wetland and deepwater habitats, but the *Palustrine Wetlands System* includes only wetland habitats. Also see *Wetlands*, *Wetlands*, *Palustrine* and *Wetland and Deepwater Habitat Classification System*.

Deferred Junction — The point at which a *Deferred Stream* joins the main stream. Also referred to as a *Deferred Tributary Junction*.

Deferred Stream — A tributary stream that flows parallel to the main stream for a significant distance before joining it downstream. Also referred to as a *Deferred Tributary*.

Deflation Basin — (1) An erosion basin excavated by ice in front of a barrier that obstructs the path of a glacier. (2) (Geology) A topographic depression formed and maintained by wind erosion. Also referred to as a *Wind-Scoured Basin*.

Deflection Pool — A pool that occupies a depression hollowed out by a stream at a curve in its course.

Deflocculate — To cause the particles of the disperse phase of a colloidal system to become suspended in the dispersion medium.

Deflocculating Agent — A material added to a suspension to prevent settling.

Deflocculation — Breakup of flocs of gel structures by use of a thinner.

Defluoridation — (Water Quality) (1) The removal of excess fluoride in drinking water to prevent the mottling (brown stains) of teeth. (2) A process by which the level of fluoride in a water is reduced to prevent mottling of teeth or fluorosis in consumers. Either activated alumina or bone charcoal is used in the process.

Defog — To remove condensed water vapor from a surface.

Deformed Ice — A general term for ice which has been squeezed together and forced upwards and downwards in places. Subdivisions are rated ice, ridge ice, hummocked ice, and other similar deformations.

Deformed Meanders — The more typical pattern of curvature of a stream system resulting from the distortion of the more ideal sinusoidal curve pattern of a meandering stream system. The most prominent deformations occur as cutoffs, either chute cutoffs, in which the flow cuts across the based of a meander loop, or as loop or neck cutoffs, in which a meander loop closes upon itself until the flow cuts across the narrow neck formed thereby. Loop cutoffs are the end result of a migrating meander impinging upon an erosion-resistant formation. See *Meandering Channels*.

Defrost — (1) To remove ice or frost from. (2) To cause to thaw.

Degasification — (1) A water treatment process that removes dissolved gases from the water. (2) A water treatment process which removes dissolved gases from the water. The gases may be removed by either mechanical or chemical treatment methods or a combination of both.

Deglaciation — The uncovering of a land mass from beneath glacial ice as a result of the melting and shrinking of the ice.

Degradation — (1) The vertical erosion of a stream to establish or maintain uniformity of grade. (2) A shrinkage or disappearance of permafrost. (3) Any lowering of a stream bed. any lowering of a stream bed. (Geology) (4) The wearing down of land by erosion. (5) The geologic process by means of which various parts of the surface of the earth are worn down and carried away and their general level lowered, by the action of wind and water.

Degradation (of River Beds or Stream Channels) — The general lowering of the streambed by erosive processes, such as scouring by flowing water. The removal of channel bed materials and downcutting of natural stream channels. Such erosion may initiate degradation of tributary channels, causing damage similar to that due to gully erosion and valley trenching. Opposite of *Aggradation*.

Degrade — The lowering of a stream-channel bed with time due to the erosion and transport of bed materials or the blockage of sediment sources.

Degraded Water — Water within the groundwater basin that, in one characteristic or another, does not meet primary drinking water standards.

Degrading Stream — A stream that is actively downcutting its channel or valley.

Degree Day — The difference, expressed in degrees, between the mean temperature for a given day and a reference temperature (usually 0EC).

Degree of Protection — The amount of protection that a flood control measure is designed for, i.e., 100-year, as determined by engineering feasibility, economic criteria, and social, environmental, and other considerations. Also see *Level of Protection*.

Dehumidify — To remove atmospheric moisture from.

Dehydratase — (Biochemistry) An *Enzyme* that catalyzes the removal of oxygen and hydrogen from organic compounds in the form of water.

Dehydrate — (1) To lose water from body tissues or foods. (2) To remove bound water or hydrogen and oxygen from (a chemical compound) in the proportion in which they form water. (3) To remove water from (as foods). (4) To remove water from; make *Anhydrous*. (5) To Lose water or moisture; become dry.

Dehydration — (1) The process of removing water from a substance or compound. (2) Excessive loss of water from the body or from an organ or a body part, as from illness or fluid deprivation.

Dehydrator — (1) A substance, such as sulfuric acid, that removes water. (2) A container or an engineered system designed to remove water from substances such as absorbents or food.

Deice — To make or keep free of ice; melt ice from.

Deicer — (1) A device used on an aircraft to keep the wings and propellers free from ice or to remove ice after it has formed. (2) A compound, such as ethylene glycol, used to prevent the formation of ice, as on windshields.

Deionization — The removal of all charged atoms or molecules from some material such as water. For example, the removal of salt from water involves the removal of sodium ions (Na⁺) and chloride ions (Cl⁻). The process commonly employs one resin that attracts all positive ions and another resin to capture all negative ions. Also see *Capacitive Deionization*.

Deionize — To remove ions from water by *Ion Exchange*. See *Deionization*.

Deionized Water — Water that has been passed through resins that remove all ions. Also see *Deionization*.

Delay Time — Duration of time for contamination or water to move from point of concern to the well; analogous to time-of-travel.

Delayed Runoff — (1) Runoff from melted snow or ice. (2) Runoff that sinks into the ground and later discharges into streams.

Delegated State — A state (or other governmental entity such as a tribal government) that has received authority from the U.S. *Environmental Protection Agency (EPA)* to administer an environmental regulatory program in lieu of a federal counterpart. As used in connection with *National Pollutant Discharge Elimination System (NPDES)*, *Underground Injection Control (UIC)*, and *Public Water System (PWS)* programs, the term does not connote any transfer of federal authority to a state. Also see *Primacy*.

Delineation — The process of deciding where something, for example, the boundaries of a *Wetland*, begins and ends.

Deliquesce — (1) To melt away; to disappear as if by melting. (2) (Chemistry) To dissolve and become liquid by absorbing moisture from the air.

Deliquescence — The process whereby substances absorb water from the air, and eventually form solutions.

Delivery (Irrigation) — (1) The release of water from turnouts to water users. (2) The amount of irrigation water delivered to a

water-user's headgate during the irrigation season.

Delivery Box — An irrigation structure for diverting water from a canal to a farm unit, often including measuring devices.

Delivery Concept — The mode of making deliveries with respect to time; types are rotation, scheduled, or demand deliver concepts.

Delivery Flexibility — The flexibility that water users have in requesting delivery changes and the ability of the canal system to accommodate the request.

Delivery/Release — The amount of water delivered to the point of use and the amount released after use; the difference between these amounts is usually the same as the *Consumptive Use*.

Delivery System — A system which conveys water from a single source, such as a storage reservoir, to a number of individual points of use. The delivery system is a common classification. It is associated with irrigation, municipal and industrial use, and fish and wildlife canal systems.

Delta — (1) An alluvial deposit made of rock particles (sediment and debris) dropped by a stream as it enters a body of water. (2) A plain underlain by an assemblage of sediments that accumulate where a stream flows into a body of standing water where its velocity and transporting power are suddenly reduced. (3) The low, nearly flat, alluvial tract of land deposited at or near the mouth of a river, commonly forming a triangular or fan-shaped plain of considerable area enclosed and crossed by many distributaries of the main river. Originally so named because many deltas are roughly triangular in plan, like the Greek letter delta (Δ), with the apex pointing upstream.

Delta Bar — (Geology) A ridgelike accumulation of alluvial material formed by a tributary stream that is building a delta into the channel of the main stream.

Delta Front — (Geology) A narrow, continuous sheet of sand that marks the zone where deposition in a delta is most active.

Delta Kame — (Geology) A hill of stratified sand and gravel that was deposited by a meltwater stream flowing into a proglacial lake. Also referred to as a *Kame Delta*.

Delta Lake — A lake that is formed along the edge of or within a *Delta*.

Delta Plain — (Geology) (1) A plain formed by the deposition of alluvium on the landward part of a large *Delta*. (2) Plains formed by the accumulation of fine sediment at the mouth of a stream or by overflow along the lower course of a stream.

Deltaic Deposit — (Geology) A sedimentary deposit consisting of a mixture of sand, clay, and organic matter laid down in a delta.

Deluge — (1) A great flood. (2) A heavy downpour.

Demand (Water) — (1) Maximum water use under a specified condition. (2) The quantity of water or water derived energy or services which will be used at given costs or prices of sale. (3) The amount of water that a water-right owner calls for or requests in any one irrigation season.

Demand Delivery — A method of irrigation water delivery whereby the project delivers water to the headgate upon farm irrigator demand; usually is associated with high head (cfs) delivery rates. Unrestricted use of the available water supply with limitations only on maximum flow rate and total allotment.

Demand Hardening — Occurs when governmental and/or other water regulatory agencies implement water conservation programs that result in permanent reductions in water use, such as retrofitting plumbing fixtures or installing low water use landscaping. These measures lessen agencies' ability to implement rationing to reduce water use during droughts, and can result in greater impacts to urban water users (e.g., loss of residential landscaping) when rationing is imposed. Consequently, previous water savings goals (i.e., 15 percent reduction in overall water use) become increasingly more difficult to duplicate.

Demand Management Alternatives — Water management programs that reduce the demand for water, such as water conservation, drought rationing, rate incentive programs, public awareness and education, drought landscaping, etc.

Demersal — (1) Dwelling at or near the bottom of a body of water, such as demersal fish. (2) Sinking to or deposited near the bottom of a body of water, such as demersal fish eggs.

Demineralization, also Demineralize — The act or treatment process that removes dissolved minerals or mineral salts from a liquid, such as water.

Demineralized Water — Water which has been passed through a mixed-bed ion exchanger to remove soluble ionic impurities. Nonelectrolytes and *Colloids* are not removed from water so treated. Also referred to as *Deionized Water*.

Demographics — Relating to the statistical study of human populations to include such characteristics and factors as population counts, births, deaths, migration, sex, age, and related statistics.

Demography — The statistical science dealing with the distribution, density, vital statistics, and other related characteristics of population. *Demographics* is the adjective describing the various characteristics of a population.

Dendritic — (1) Referring to a drainage pattern in which tributaries branch irregularly in all directions from and at almost any angle to a larger stream. (2) A tree-like pattern, typical of most drainage networks. From an aerial view, it resembles the branching pattern of trees. (3) The form of the drainage pattern of a stream and its tributaries when it follows a treelike shape, with the main trunk, branches, and twigs corresponding to the main stream, tributaries, and sub-tributaries, respectively, of the stream.

Dendritic Drainage Pattern — A pattern of natural stream courses in which the streams branch irregularly in all directions and at any angle.

Dendrochronology — (1) Dating an object by means of tree rings. The study of tree-ring configuration to determine hydrologic occurrences; variations in the width reveal variation in precipitation or water flow. (2) The technique of dating events, determining climatic conditions, growth patterns, etc. through the use of tree rings. Also see *Dendrohydrological Reconstruction*.

Dendrohydrological Reconstruction — Tree-ring reconstructions of streamflow can be highly useful in augmenting existing instrumental streamflow data. Trees are natural recorders of climatological changes and have proven to be useful for extending the records of climate and streamflow back hundreds of years. Tree growth is relatively sensitive to a variety of climatic and non-climatic factors which are integrated into the growth patterns associated with annual tree ring widths. In this manner, tree rings can be effective proxies for streamflow, because trees in selected locations typically respond to a specific set of climate-related

factors, including precipitation and evapotranspiration, that also influence streamflow changes. In particular, trees growing in the semi-arid western United States depend on winter precipitation to recharge soil moisture, and thus are useful for reconstructing annual streamflow records.

Denitrification — (Water Treatment) (1) The physical process of removing nitrate from water through reverse osmosis, microfiltration, or other means. (2) The biochemical conversion of nitrate and nitrite; nitrogen in the soil dissolved in water to gaseous nitrogen. (3) The removal of nitrate ions (NO_3^-) from soil or water; involves the *Anaerobic* biological reduction of nitrate to nitrogen gas. The process reduces desirable fertility of an agricultural field or the extent of undesirable aquatic weed production in aquatic environments. (4) An anoxic process that occurs when nitrite or nitrate ions are reduced to nitrogen gas and nitrogen bubbles are formed as a result of this process. The bubbles attach to the biological floc in the activated sludge process and float the floc to the surface of the secondary clarifiers. This condition is often the cause of rising sludge observed in secondary clarifiers or gravity thickeners. Also see *Nitrification* and *Denitrifying Bacteria*.

Denitrifying Bacteria — Bacteria in soil or water that are capable of anaerobic respiration, using the nitrate ion as a substitute for molecular oxygen during their metabolism. The nitrate is reduced to nitrogen gas (N_2), which is lost to the atmosphere during the process.

Denizen — (Ecology) An animal or a plant naturalized in a region.

Dense Non-Aqueous Phase Liquids (DNAPLs) — Liquids such as chlorinated solvents, creosote-based wood-treating oils, coal tar wastes, and pesticides that are immiscible (i.e., they are not dissolved in water) fluids (and most commonly organic) with a density greater than water.

Density — (1) Matter measured as mass per unit volume; a measure of how heavy a substance (solid, liquid or gas) is for its size. Density is expressed in terms of weight per unit volume; that is, grams per cubic centimeter or pounds per cubic foot. The density of water is 1.0 gram per cubic centimeter or about 62.4 pounds per cubic foot. (2) Matter measured as mass per unit volume expressed in pounds per gallon (lb/gal), pounds per cubic foot (lb/ft³), and kilograms per cubic meter (kg/m³). The mass of quantity of a substance per unit volume. (3) (Biology) The number per unit area of individuals of any given species at any given time. A term used synonymously with *Population Density*.

Density Current — (1) A flow of water maintained by gravity through a large body of water, such as a reservoir or lake, which retains its identity because of a difference in density. (2) Submerged gravity-driven flows which occur when inflows to a water body are denser than the ambient water. The inflow subsequently plunges and continues as a distinct flow which can be envisioned as a submerged stream. Density currents, also called *Underflows*, are known to form intermittently on coastal continental shelves, in reservoirs and at effluent discharge sites.

Density of Snow — The ratio, expressed as a percentage, of the volume which a given quantity of snow would occupy if it were reduced to water, to the volume of the snow. When a snow sampler is used, it is the ratio expressed as percentage of the scale reading on the sampler to the length of the snow core or sample.

Density Stratification — (1) The arrangement of water masses into separate, distinct horizontal layers as a result of differences in density. Such differences may be caused by differences in temperature or dissolved and suspended solids. (2) The division of a lake or other body of water into horizontal layers as a result of differences in density; the lightest layer occurs near the top and the heaviest layer near the bottom of the lake. Also see *Thermal Stratification*.

Deoxygenate — To remove dissolved oxygen from a liquid, such as water.

Department of Conservation And Natural Resources [Nevada] — The mission of the Department is to conserve, protect, manage, and enhance the Nevada's natural resources in order to provide the highest quality of life for Nevada's citizens and visitors. The Department consists of nine divisions and/or agencies which include:

- [1] **Division of Conservation Districts** – Regulates the activities of the state's locally elected conservation districts which work for the conservation and proper development of the state's renewable natural resources by providing services to individual landowners and coordination with other public and private agencies.
- [2] **Division of Environmental Protection (DEP)** – Responsible for the administration and enforcement of all environmental statutes and regulations; issues permits, monitors for air and water pollution and inspects solid and hazardous waste management. The Division consists of the *Bureau of Air Quality*, the *Bureau of Water Pollution Control*, *Bureau of Mining Regulation and Reclamation*, *Bureau of Water Quality Planning*, *Bureau of Corrective Actions*, *Bureau of Waste Management*, and the *Bureau of Federal Facilities*. The *State Environmental Commission* is also part of the Division and is responsible for adopting necessary environmental rules, regulations and plans authorized by statute.
- [3] **Division of Forestry** – Manages and coordinates all forestry, nursery, endangered plant species and watershed resource activities on certain public and private lands; responsible for protecting structural and natural resources through fire protection, prevention and suppression. The Division also conducts the Forestry Conservation Camps Program which coordinates and supervises the outside work performed by inmates residing in Department of Prison conservation camps.
- [4] **Division of State Lands** – Acquires, holds, and disposes of all state lands and interests in lands; provides technical land-use planning assistance, training, and information to local units of government or other agencies; develops policies and plans for the use of lands under federal management and represents the state in its dealings with the federal land management agencies.
- [5] **Division of State Parks** – Plans, develops, and maintains a system of parks and recreational areas for the use and enjoyment of residents and visitors. The Division also preserves areas of scenic, historic, and scientific significance in Nevada.
- [6] **Division of Water Planning** – Provides technical, financial and economic assistance to government agencies and

individual citizens concerning regional and local water supplies; develops and implements a statewide water resource management plan and policy initiatives on a watershed basis; conducts hydrologic, climatologic, and socioeconomic data collection, research, modeling, forecasting and data analysis; develops and implements water resource public information and education programs; provides technical and financial assistance and outreach programs to assist local governments, watershed planning groups, and other agencies with respect to water resource matters; and develops and implements a statewide water conservation program. [Note: The Division of Water Planning was eliminated in the Fall of 2000 and some of its functions incorporated into the Division of Water Resources.]

- [7] **Division of Water Resources** – Responsible for protecting the health and safety of Nevada citizens through the appropriation of public waters. Other responsibilities include the adjudication of claims of vested water rights; distribution of water in accordance with court decrees; review of water availability for new major construction and housing projects; review of the construction and operation of dams; appropriation of geothermal resources; licensing of well drillers and water right surveyors; review of flood control projects; maintenance of water resource data and records; and providing technical assistance to government boards, offices, and agencies.
- [8] **Division of Wildlife** – Preserves, protects, manages and restores wildlife and its habitat within the state for aesthetic, scientific, recreational and economic benefits; tasked with promoting safety for persons and property in the operation of equipment and boating vessels
- [9] **Natural Heritage Program** – Serves as a centralized repository containing detailed information on sensitive (threatened and endangered) species of animals, plants, and communities; provides information on biology, habitats, locations, population and conservation status, and management needs.

(United States) Department of the Interior (USDI) — Originally established by Congress in 1849 as the executive department of the United States government, the USDI's function has changed from that of performing housekeeping duties for the federal government to its present role as custodian of the nation's natural resources. As the nation's principal conservation agency, the USDI has the responsibility of protecting and conserving the country's land, water, minerals, fish, and wildlife; of promoting the wise use of all these natural resources; of maintaining national parks and recreation areas; and of preserving historic places. It also provides for the welfare of American Indian reservation communities and of inhabitants of island territories under U.S. administration. As of 1988 the USDI managed more than 220 million hectares (550 million acres, or 850,000 square miles) of federal resource lands; about 340 units of the national park system; 70 fish hatcheries, and 442 *National Wildlife Refuges (NWF)*; and numerous reclamation dams that provide water, electricity, and recreation. The USDI also constructs irrigation works, enforces mine safety laws, makes geological surveys and prepares maps, conducts mineral research, and administers wild and scenic rivers as well as national and regional trails. The USDI is currently in charge of the *Bureau of Indian Affairs (BIA)*, the *U.S. Fish and Wildlife Service (USFWS)*, the *National Park Service (NPS)*, and the *U.S. Geological Survey (USGS)*. It also oversees the Bureau of Mines, which is responsible for ensuring that the nation has adequate mineral supplies and for overseeing and evaluating all aspects of minerals research; the *U.S. Bureau of Land Management (BLM)*, which manages public lands and their resources; the *U.S. Bureau of Reclamation (USBR)*, which assists local governments in reclaiming arid lands in western states and provides programs for hydro-electric power generation, flood control, and river regulation; the Minerals Management Service, which deals with leasable minerals on the Outer Continental Shelf and ensures efficient recovery of mineral resources; and the Office of Surface Mining Reclamation and Enforcement, which helps to protect the environment from adverse effects of mining operations. Other agencies under the USDI's jurisdiction include the Office of Small and Disadvantaged Business Utilization and the Office of Territorial and International Affairs.

Department of Water Resources (DWR) [California] — The California state agency within *The Resources Agency* that is responsible for long-term water planning, operation of the *State Water Project*, and state water conservation programs. The basic goal of the DWR is to ensure that California's needs for water supplies, water-related recreation, fish and wildlife, hydroelectric power, prevention of damage and loss of life from floods and dam failure, and water-related environmental enhancements are met; and to ensure that the manner in which these needs are fulfilled is consistent with public desires and attitudes concerning environmental and social considerations. The *California Water Commission*, also within The Resources Agency, serves as a policy advisory body to the Director of the DWR on matters within the department's jurisdiction and coordinates state and local views on federal appropriations for water projects in California. The commission also conducts public hearings and investigations statewide for the department and provides an open forum for interested citizens to voice on water development issues. The *California State Water Resources Control Board (SWRCB)*, located within the California Environmental Protection Agency, is assigned the responsibility to protect water quality and allocate water rights.

Depauperate — (Biology) An area poor in species quantities and/or diversity; an aquatic sample showing few life forms. Impoverished habitat.

Dependable Supply — (1) That water which can be expected to be available at a time and place with the quality demanded; sometimes the amount of water available is at a stated percentage of time. (2) The average annual quantity of water that can be delivered during a drought period.

Dependable Yield — The maximum annual supply of a given water development that is expected to be available on demand, with the understanding that lower yields will occur in accordance with a predetermined schedule or probability. More frequently referred to as *Firm Yield*.

Depergelation — The decay or thawing of permafrost.

Depletion — (1) The water consumed within a service area or no longer available as a source of supply; that part of a withdrawal that has been evaporated, transpired, incorporated into crops or products, consumed by man or livestock, or otherwise removed. (2) Net rate of water use from a stream or groundwater aquifer for beneficial and nonbeneficial uses. For irrigation or municipal uses, the depletion is the headgate or wellhead diversion minus return flow to the same stream or groundwater aquifer. For

agriculture and wetlands, it is the *Evapotranspiration of Applied Water (ETAW)* (and *Evapotranspiration (ET)* of flooded wetlands) plus irrecoverable losses. For urban water use, it is the ETAW (water applied to landscaping or home gardens), sewage effluent that flows to a salt sink, and incidental ET losses. For instream use, it is the amount of dedicated flow that proceeds to a salt sink and is not available for reuse.

Depletion (Groundwater) — The withdrawal of water from a source at a rate greater than its rate of recharge, usually over an extended period of several years.

Depletion (Streamflow) — The amount of water that flows into a valley, or onto a particular land area, minus the water that flows out of the valley or off from the particular land area.

Depletion (Water) — That portion of the water supply that is consumptively used.

Depletion Curve — (1) That part of the *Hydrograph* extending from the point of termination of the *Recession Curve* to the subsequent rise or alternation of inflow due to additional water becoming available for stream flow. (2) (Hydraulics) A graphical representation of water depletion from storage-stream channels, surface soil, and groundwater. A depletion curve can be drawn for base flow, direct runoff, or total flow.

Deposit — Something dropped or left behind by moving water, as sand or mud.

Depositing Substrates — Bottom areas where solids are being actively deposited; often occurring in the vicinity of effluent discharges.

Deposition — The accumulation of material dropped because of a slackening movement of the transporting medium, e.g., water or wind. Also, the transition of a substance from the vapor phase directly to the solid phase, without passing through an intermediate liquid phase, also referred to as *Sublimation*.

Depression — (Geology) A relatively sunken or low-lying area of the earth's surface, especially one having no natural outlet for surface drainage.

Depression Spring — A spring whose waters flow from permeable material onto the land surface because the land slopes down to the water table.

Depression Storage — (1) Water contained in natural depressions in the land surface, such as puddles or ditches. (2) The volume of water that is temporarily detained on the surface of the earth in puddles and cavities that have little or no surface outlet.

Depth (often Depths) — (1) A deep part of a place, as the ocean depths. (2) The vertical measure of any body of water. (3) (Oceanography) The vertical distance below the sea surface at any given point, especially the sea floor.

Depth-Area-Duration Analysis — Determination of the maximum amounts of precipitation within various durations over areas of various sizes; used to predict flood events.

Depth Finder — An instrument used to measure the depth of water, especially by radar or ultrasound.

Depth Hoar — Delicate stepped or layered ice crystals that are formed below the surface of snow, usually near the bottom of a thick snow cover. Also referred to as *Sugar Snow*.

Depth of No Motion — (Oceanography) The depth at which submarine water movement caused by surface waves practically ceases; generally at a depth equal to a surface wavelength.

Depth of Runoff — The total runoff from a *Drainage Basin* divided by its area. For convenience in comparing runoff with precipitation, depth of runoff is usually expressed in inches during a given period of time over the drainage area expressed in inches per square mile.

Depth Sounder — An ultrasonic instrument used to measure the depth of water under a ship.

Depuration — A process during which an organism, such as an oyster or clam, eliminates dangerous chemicals or microorganisms when placed in uncontaminated water.

Derelict — (Legal) Land left dry by a permanent recession of the water line.

Derelict Land — (Ecology) A term for land that has been seriously damaged by industrial activity, such as strip mining.

Dereliction — (Legal) (1) A gaining of land by the permanent recession of the water line. (2) The land so gained. Also see *Reliction* and *Doctrine of Reliction*.

Dermal Exposure — Contact between a chemical and the skin.

Desalination, or Desalinization — (1) To remove salt and other chemicals from sea water or saline water. The removal of dissolved salts (such as sodium chloride, NaCl) from water by natural means (leaching) or by specific water treatment processes. (2) Any process for making potable water from sea water or other saline waters. Includes distillation, electrodialysis, freezing, foam separation, liquid-liquid extraction, ion exchange, and various non-electric membrane processes. (3) To remove salts and other chemicals, as from sea water or soil, for example. Usually used with respect to the salt contained in water. (4) Specific treatment processes to demineralize sea water or brackish (saline) water for reuse. Also referred to as *Desalting*.

Desalinize — See *Desalination* or *Desalinization*.

Desalting (or Desalination) — (1) A term used to refer to any process by which the dissolved solids content of saline water or seawater is reduced. (2) Specific treatment processes, such as reverse osmosis or multi-stage flash distillation, to demineralize seawater or brackish (saline) waters for reuse. Also sometimes used in wastewater treatment to remove salts other pollutants. Also known as *Desalination*, *Desalinization*, or *Saline Water Conversion*.

De-Seasonalization — (Statistics) A process which removes the seasonal effects from time series data. One way to determine if a de-seasonalization transformation of the data is necessary is to examine the autocorrelations. If, for monthly data, the twelfth autocorrelation is abnormally high, or for quarterly data, the fourth autocorrelation abnormally high, then the data is seasonal in nature and requires de-seasonalization before attempting to fit a model to its behavior. More frequently referred to as *Seasonal Adjustment (S.A.)*. Also see *Seasonal Adjustment*, *Seasonal Adjustment Factors*, *Seasonal Factors*, and *Seasonality*.

Desert — A barren or desolate area, especially one characterized by dry, often sandy conditions of little rainfall, typically less than 10 inches of rain per year, extreme temperatures, and sparse vegetation. Also see *Biome*.

Desert National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Desert NWR was established in 1936 and covers 1,588,459 acres (2,482 square miles) of the diverse Mohave Desert in southern Nevada and is the largest National Wildlife Refuge in the 48 contiguous United States. The Desert NWR's most important objective is the perpetuation of the desert bighorn sheep and its habitat. The refuge contains six major mountain ranges, the highest rising from a 2,500 foot elevation valley floor to nearly 10,000 feet. The dry climate and varying elevations provide varied plant life with creosote bush and white bursage dominant in the lower elevations, Mojave yucca and cactus dominant in the mid-elevations, blackbrush and Joshua trees prevalent near 6,000 feet, and single-leaf pinyon and Utah juniper become prominent at 6,000 feet. From 7,000–9,000 feet Ponderosa pine and white fir become dominant and near 10,000 feet the only remaining tree is the bristlecone pine. Throughout this area the big sagebrush is the most common shrub. Within this refuge, and in stark contrast to the typical habitat and wildlife prevalent throughout the refuge, are the numerous and diverse plant and animal communities at Corn Creek. Here springs turn the desert into an oasis attracting over 200 species of birds alone. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Desert Pavement — Surfaces of tightly packed gravel that armor, as well as rest on, a thin layer of silt, presumably formed by weathering of the gravel. They have not experienced fluvial sedimentation for a long time, as shown by the thick varnish coating the pebbles, the pronounced weathering beneath the silt layer, and the striking smoothness of the surface, caused by obliteration of the original relief by downwashing into depressions.

Desert Research Institute (DRI) [University of Nevada and Community College System] — Desert Research Institute (DRI) is the research and technology branch of the University of Nevada System specializing in issue definition, development, and technical research programs in the areas of water resources, air quality, global climate change, and the physics of the Earth's turbulent atmosphere. DRI scientists also study humanity's historic struggle to adapt to harsh environments, and its urgent search today for the technology of the next century. DRI pursues a full-time program of basic and applied environmental research on a local, national, and international scale. DRI's nearly 400 full-time and part-time scientists, technicians, and support personnel conduct some 140 research projects annually. Created in 1959 by an act of the Nevada Legislature, DRI was initially established as part of the University of Nevada. When the University of Nevada System was formed in 1968, DRI became an autonomous, nonprofit division of Nevada's University and Community College System. DRI has been designated as Nevada's *Water Resources Research Institute (WRI)* under the *Water Resources Research Act* (Public Law 101-147) and is part of the *National Water Resources Research Institute Program*. Over its 40-year history, DRI has grown to be one of the world's largest multi-disciplinary environmental research organizations in the world. DRI operates a not-for-profit environmental research campus – Dandini Research Park – just north of Reno, Nevada. Here, and at its other research and experimental locations, DRI conducts its many investigative programs through three primary divisions:

- [1] **Division of Atmospheric Sciences (DAS)** – DRI's Division of Atmospheric Sciences conducts fundamental and applied research into the natural atmosphere and local and regional studies of air quality. This work is undertaken in response to the needs of both public and private organizations. The DAS specializes in the development of instrumentation and techniques for ground-based, aircraft, and satellite observational programs. Inorganic and organic chemistry laboratories allow analysis of human impacts on air quality and detection and quantification of atmospheric pollutants, at trace levels. Modeling capabilities include basic research in atmospheric dynamics and cloudiness, improvement of mesoscale and regional scale predictions, the transportation and dispersion of pollutants in complex terrain, urban air quality, linking meteorology and air quality, and climate. The DAS's Western Regional Climate Center is one of six *National Oceanic and Atmospheric Administration (NOAA)* funded regional centers that comprise a climate-services network serving the entire United States and its territories. The Climate Center provides data and products tailored to the individual needs of a wide variety of federal agencies, regional organizations, state and local bodies, and the private sector. The DAS's atmospheric research capabilities are conducted in two primary research areas: (1) atmospheric science research and (2) air quality research. Atmospheric and air quality studies include some of the following water-related issues:

- Cloud Chemistry
- Cloud Condensation Nuclei
- Coalescence
- Precipitation Processes
- Droplets
- Ice Crystals/Cirrus
- Climate Change and Variability
- Mountain Meteorology and Orographic Cloud Systems
- ENSO and Western Climate

- [2] **Division of Earth and Ecosystem Sciences (DEES)** – DRI's Division of Earth and Ecosystem Sciences focuses on achieving excellence in basic scientific research into how natural and agricultural ecosystems function and respond to natural and human-caused disturbances. The results of this basic research lead directly to more effective management of biological resources. DEES's scientific niche is characterized by two important themes: (1) understanding the way biological systems respond to perturbations across multiple temporal scales (e.g., seconds, years, decades, etc.) and multiple spatial scales (e.g., millimeters, meters, hectares, etc.); and (2) understanding whether different kinds of ecosystems (e.g., deserts, forests, lakes, shrub lands, marshes, etc.) function and respond to disturbance in similar ways and whether there are key fundamental parameters that determine how an ecosystem responds to disturbance. The DEES's Frits Went Laboratory in Reno is a one-of-a-kind controlled environment

facility allowing for the simulation of environmental perturbations in precisely controlled miniature ecosystems. DEES also participates in one of the most diverse Quaternary research programs worldwide, involving disciplines such as archaeology, geomorphology, pedology, paleocology, geochronology, geobotany, and remote sensing. The focus is on ways to improve the fundamental understanding of the nature of the Earth's dynamic surface from approximately 2 million years ago to the present day (i.e., Pleistocene and Holocene Epochs) and apply this knowledge toward enhancing effective management of the environment and cultural resources. Some of DEES's research capabilities dealing with water include:

- Bioremediation Using Microbes
- Bioaccumulation and Biotransformations
- Plant-Soil-Water Relationships
- Geomorphic Processes of Fluvial, Eolian, and Hillslope Systems
- Climatic and Tectonic Influences on Geomorphic Processes
- Paleocology, Paleoclimatology, and Paleohydrology
- Paleolimnology of Playas and Pluvial Lakes
- Pedology and Soil Geomorphology
- Soil, Water, and Vegetation Relationships
- Paleoflood Hydrology and Flood-Climate Linkages
- Spectral and Biogeochemical Techniques for Hazardous Water Assessment
- Arid Ecosystem Characterization and Desertification

[3] **Division of Hydrologic Sciences (DHS)** — DRI's Division of Hydrologic Sciences is the largest water research group in the United States which is specifically focused on more effective management of hydrologic resources on arid lands. The Division conducts groundwater contaminant research and has pioneered techniques for detection and monitoring of organic substances in groundwater systems. DHS maintains state-of-the-art water quality and water age-dating laboratories, and has pioneered the application of remote sensing techniques to gather and interpret surface hydrologic indicators such as soil moisture and snow-pack water content. Chemical and isotopic analysis is also being applied to DRI's water research programs. Some of the DHS's research capabilities include the following areas:

- Hydrogeology
- Unsaturated and Saturated Flow and Transport
- Hydrothermal Systems
- Saline Lake Hydrology
- Karst Hydrology
- Water Quality and Groundwater Protection
- Water Resource Delineation
- Hydrostratigraphy
- Isotope Hydrology
- Hydrologic Cycle and Physical/Chemical Processes

Desert Stream Valley — The valley of a perennial stream that is fed from mountain sources and is erosionally-cut through several desertic *Semi-Bolson*s.

Desert Varnish — A dark coating (from 2 to 500 microns thick) that forms on rocks at and near the Earth's surface as a result of mineral precipitation and *Eolian* influx. The chemical composition of rock varnish typically is dominated by clay minerals and iron and/or manganese oxides and hydroxides, forming red and black varnishes, respectively. With time the thickness or the coating increases if abrasion and burial of the rock surface do not occur. As a result, *Clastic* sediments on alluvial fan surfaces that have been abandoned for long periods of time have much darker and thicker coatings of varnish than do younger deposits.

Desertification — (Ecology) (1) The development of desert conditions in an area that was previously not an arid environment, for example as a result of climatic changes or human activity. (2) Conversion of rangeland, rain-fed cropland, or irrigated cropland to desert-like land, with a drop in agricultural productivity of 10 percent or more. It is usually caused by a combination of overgrazing, soil erosion, prolonged drought, and climate change. (3) The transformation of arable or habitable land to desert, as by a change in climate or destructive land use. The term is generally applied to the production of artificial deserts where people have intensified the problems caused by droughts through overgrazing marginal land, repeated burning of natural vegetation, intensive farming of arid land, aggressive removal of trees, and prolonged irrigation of arid land for agricultural use.

Desiccant — (1) A drying agent which is capable of removing or absorbing moisture from the atmosphere in a small enclosure. (2) A substance, such as calcium oxide or silica gel, that has a high affinity for water and is used as a drying agent.

Desiccate — (1) To dry out thoroughly. (2) To preserve (foods) by removing moisture.

Desiccation — (1) A process used to thoroughly dry air; to remove virtually all moisture from air. (2) Any process of moisture removal. Also referred to as *Exsiccation*. (3) A decrease or withdrawal of water from an area as a result of climatic change, erosion, or other natural or artificial processes. (4) The complete drying of a lake or other body of water. (5) Loss of water from pore spaces of sediments through compaction or through evaporation caused by exposure to air. (6) (Geology) Used to refer to a long period of time between *Pluvial* (wet) episodes.

Desiccation Cracks — Surface fractures that can result from the drying of soil or porous sedimentary rock.

Desiccator — A closed container into which heated weighing or drying dishes are placed to cool in a dry environment. The dishes may be empty or they may contain a sample. Desiccators contain a substance, such as anhydrous calcium chloride, which absorbs

moisture and keeps the relative humidity near zero so that the dish or sample will not gain weight from absorbed moisture.

Design Capacity — (1) Volume of water that a channel, pipe, or other drainage line is designated to convey. (2) The average daily flow that a water or wastewater treatment plant or other facility is designed to accommodate.

Design Criteria (Dam) — The hypothetical flood used in the sizing of the dam and the associated structures to prevent dam failure by overtopping, especially for the spillway and outlet works.

Design Flood — (1) The flood against which a given area is to be protected. (2) Commonly used to mean the magnitude of flood used for design and operation of flood control structures or other protective measures. It is sometimes used to denote the magnitude of flood used in floodplain regulations. (3) The flood magnitude selected for use as a criterion in designing flood control works. The largest flood that a given project is designed to pass safely. In dam design and construction, the reservoir inflow-outflow hydrograph used to estimate the spillway discharge capacity requirements and corresponding maximum surcharge elevation in the reservoir.

Design Flow — The average flow of wastewater that a treatment facility is built to process efficiently, commonly expressed in millions of gallons per day (MGD).

Design Runoff Rate — In irrigation, the maximum runoff rate expected over a given period of time.

Designated Floodway — The channel of a stream and the portion of the adjoining floodplain designated by a regulatory agency to be kept free of further development to provide for unobstructed passage of flood flows.

Designated Groundwater Basin — A basin where permitted rights approach or exceed the estimated average annual recharge and the water resources are being depleted or require additional administration. Under such conditions, a state's water officials will so designate a groundwater basin and, in the interest of public welfare, declare *Preferred Uses* (e.g., municipal and industrial, domestic, agriculture, etc.). Also referred to as *Administered Groundwater Basin*.

Designated Groundwater Basin [Nevada] — In the interest of public welfare, the Nevada State Engineer, *Division of Water Resources, Department of Conservation and Natural Resources*, is authorized by statute (Nevada Revised Statute 534.120) and directed to designate a basin and declare *Preferred Uses* within such designated basin. The State Engineer has additional authority in the administration of the water resources within a designated basin.

Designated Use Classifications — Classification of a waterbody or segment based on the purposes (beneficial uses) for which the waterbody may be used as specified in water quality standards.

Designated Uses — Those water uses identified in state water quality standards that must be achieved and maintained as required under the *Clean Water Act (CWA)*. Such uses may include cold water fisheries, public water supply, irrigation, recreation, minimum stream flows, etc.

Designated Watersheds — Watershed areas that have been set aside as sources of municipal water or other similar purposes would be included in this category. Other uses are either modified or excluded.

Designer Bugs — A popular term for *Microbes* developed through *Biotechnology* that can degrade specific toxic chemicals at their source in toxic waste dumps, in, or on the land surface. May also be useful in cleaning (decomposing) oil spills.

Desilting — The physical process of removing suspended particles from water.

Desilting Area — An area of grass, shrubs, or other vegetation used for inducing the deposition of silt and other debris from flowing water. Typically located above a stock tank, pond, field, or other area needing protection from sediment accumulation.

Desorption — The removal of a substance adsorbed to the surface of an adsorbent. Also see *Sorption*, which is the reverse process.

Destratification — (1) Vertical mixing within a lake or reservoir to totally or partially eliminate separate layers of temperature, plant, or animal life. (2) The development of vertical mixing within a lake or reservoir to eliminate (either totally or partially) separate layers of temperature, plant, or animal life. This vertical mixing can be caused by mechanical means (pumps) or through the use of forced air diffusers which release air into the lower layers of the reservoir.

Detachment — The removal of transportable fragments of soil material from a soil mass by an eroding agent, usually falling raindrops, running water, or wind. Through this process, soil particles or aggregates are made ready for transport, the first stage in soil erosion.

Detectable Leak Rate — The smallest leak (from a storage tank), expressed in terms of gallons or liters per hour, that a test can reliably discern with a certain probability of detection or false alarm.

Detection Criterion — A predetermined rule to ascertain whether a tank is leaking or not. Most volumetric tests use a threshold value as the detection criterion. Also see *Volumetric Tank Tests*.

Detection Monitoring Program — Groundwater monitoring at the boundary of a treatment, storage, or disposal facility (the point of compliance) to detect any contamination caused by leaks from the hazardous waste at the facility. The materials for which the samples must be analyzed (the indicator parameters/constituents) are specified in the facility permit.

Detention Dam — A dam constructed for the purpose of temporary storage of streamflow or surface runoff and for releasing the stored water at controlled rates.

Detention Basin — (1) A relatively small storage lagoon for slowing stormwater runoff, generally filled with water for only a short period of time after a heavy rainfall. (2) Structures which are built upstream from a populated area so that precipitation flows do not flood and cause the loss of life or property. They are normally dry, but are designed to detain surface water temporarily during, and immediately after a runoff event. Their primary function is to attenuate the storm flows by releasing flows at a lower flow rate. There are no gates or valves allowed on the outlet so that water can never be stored on a long-term basis. Typical detention times in such a basin would be on the order of 24 to 72 hours although some are as long as 5 to 10 days. Also see *Retention Basin*.

Detention Facility — A surface water runoff storage facility that is normally dry but is designed to hold (detain) surface water temporarily during and immediately after a runoff event. Examples of detentional facilities are: natural swales provided with crosswise earthen berms to serve as control structures, constructed or natural surface depressions, subsurface tanks or reservoirs,

rooftop storage, and infiltration or filtration basins. Also see *Retention Facility*.

Detention Lag — The time period between the moment a change is made and the moment when such a change is finally sensed by the associated measuring instrument.

Detention Storage — (1) The volume of water, other than *Depression Storage*, existing on the land surface as flowing water which has not yet reached the channel. (2) Water temporarily detained in the non-capillary pores of the soil, free to move by gravity, which it generally does within about 24 hours of the event that filled the pores.

Detention Structure (Dam) — A structure constructed for the temporary storage of floodflows where the opening for release is of a fixed capacity and not manually operated.

Detention Time — (1) The theoretical calculated time required for a small amount of water to pass through a tank at a given rate of flow. (2) The actual time that a small amount of water is in a settling basin, flocculating basin, or rapid-mix chamber. (3) In storage reservoirs, detention time is the length of time entering water will be held before being drafted for use (several weeks to years, several months being typical).

Detention Time (Hours) — Equivalent to Basin Volume (gallons)/(24 hours/day) x Flow (gallons/day).

Detergent — Synthetic washing agent that helps to remove dirt and oil. Some contain compounds which kill useful bacteria and encourage algae growth when they are in wastewater that reaches receiving waters.

Deterministic Process — (Statistics) An analytical and forecasting technique which assumes that the future can be predicted exactly from its past. Consequently, it is assumed that the data series to be forecasted contains all the information necessary to predict its future behavior. A deterministic process or relationship is assumed to be “exact”, and therefore assumes no presence of a *Disturbance (or Error) Term*. The simplest form of this process is commonly termed an *AutoRegressive Moving Average (ARMA) Process*, or *Box-Jenkins*, which involves regressing a series on itself and using solely the historical patterns contained in the data to formulate forecasts. As a naive method, such a process does not include the capability to incorporate external “shocks” or other influences which may have an effect on the future behavior of a series. Such a technique is typically used only for well-behaved data showing typically predictable repetitive cycles and patterns. Contrast with *Stochastic Process*.

Detrital — (Geology) Clastic; rock and minerals occurring in sedimentary rocks that were derived from pre-existing igneous, sedimentary, or metamorphic rocks.

Detritus — (1) The heavier mineral debris moved by natural water courses, usually in the form of *Bed Load*. (2) The sand, grit, and other coarse material removed by differential sedimentation in a relatively short period of detention. (3) Bits of vegetation, animal remains, and other organic material that form the base of food chains in wetlands and many other kinds of habitats.

Deuterium Oxide — An isotopic form of water with composition D_2O , isolated for use as a moderator in certain nuclear reactors. Also referred to as *Heavy Water*. Also see *Heavy Water Moderated Reactor* and *Light Water Reactor (LWR)*.

Developed Water — Water that is controlled and managed (damned, pumped, diverted, stored in reservoirs or channeled in aqueducts) from rivers or otherwise developed for a variety of uses.

Development (Well) — The act of repairing damage to the formation caused by drilling procedures and increasing the porosity and permeability of the materials surrounding the intake portion of the well.

Deviation, Standard — (Statistics) A measure of the average variation of a series of observations or items of a population about their mean. In a normally distributed set of observations the interval of the mean plus or minus one standard deviation includes about two-thirds of the observations.

Dew — (1) The droplets of water condensed from air, usually at night, onto cool surfaces. (2) Water condensed onto objects near the ground, the temperatures of which have fallen below the dew point of the surface air. (3) Water that forms when water vapor from saturated air cools and condenses on a surface whose temperature is above freezing but colder than the dew point of the surface air.

Dew Point — (1) The temperature to which air with a given quantity of water vapor must be cooled to cause condensation of the vapor in the air. (2) The temperature at which a gas or vapor condenses to form a liquid; the point at which dew begins to form. (3) The temperature to which the air must be cooled in order to reach 100 percent relative humidity, or saturation. (4) A measure of atmospheric moisture. It is the temperature to which air must be cooled in order to reach saturation (assuming air pressure and moisture content are constant).

Dewater, and Dewatering — (1) To remove water from a waste produce or streambed, for example. (2) The extraction of a portion of the water present in sludge or slurry, producing a dewatered product which is easier to handle. To remove or separate a portion of the water present in a sludge or slurry. To dry sludge so it can be handled and disposed. (3) The removal of water from sludge by filtration, centrifugation, pressing, open-air drying or other methods which provide a material suitable for disposal by burning or landfilling. (4) To remove or drain the water from a tank or a trench. (5) (Mining) The removal of in conjunction with mining operations, particularly open-pit mining when the excavation has penetrated below the ground-water table. Such operations may include extensive ground-water removal and, if extensive enough and if not re-injected into the groundwater, these discharges may alter surface water (stream) flows and lead to the creation of lakes and wetland areas. As such water removals only last so long as the mine is in operation, eventually surface water impacts, if present, will be eliminated, consequently jeopardizing surface water uses, such as irrigation, livestock, wildlife, or riparian habitat that may have become dependent upon the continuation of these temporary flows. Also, when the mine dewatering operations cease, the remaining open pit will eventually begin to fill up with , resulting in significantly increased evaporation from reservoirs.

Dewaterable — (Water Treatment) This is a property of sludge related to the ability to separate the liquid portion from the solid, with or without chemical conditioning. A material is considered dewaterable if water will readily drain from it.

Diadromous — Relating to a fish that migrates between salt and fresh waters.

Diameter — The commercially designated nominal inside dimension for pipe sizes 1/8 to 12 inches, inclusive, and the outside dimension of pipe 14 inches and larger.

Diameter at Breast Height (DBH) — A measure of tree diameter determined at the standard height of 4.5 feet (1.4 meters) from the ground.

Diastraphic — (Geology) Pertaining to processes by which the earth's crust is deformed, producing continents, oceans, basins, mountains, and other *Geophysical* features. Also see *Orogenic* and *Tectonic*.

Diatom — (1) Any of a number of related microscopic algae, one-celled or in colonies, whose walls consist of two parts or valves and contain silica. (2) Any of the microscopic unicellular or colonial algae constituting the class *Bacillarieae*. They have a silicified cell wall, which persists as a skeleton after death and forms kieselguhr (loose or porous diatomite). Diatoms occur abundantly in fresh and salt waters, in soil, and as fossils. They form a large part of the *Plankton*.

Diatoma — A small genus of fresh-water diatoms typifying the family *Diatomaceae*. They sometimes cause aromatic or disagreeable odors in water.

Diatomaceous — Pertaining to, or composed largely of, the remains of microscopic plants called diatoms. These remains are made up of nearly pure silica. See *Diatomaceous Earth*.

Diatomaceous Earth — (1) A fine, siliceous (made of silica) "earth" composed mainly of the skeletal remains of diatoms, a type of free-floating, microscopic plant found in the ocean. (2) A light-colored, soft, siliceous earth composed of the shells of diatoms, a form of algae. Some deposits are of lake origin but the largest are marine. (3) A yellow, white or light-gray material composed of the siliceous shells of *Diatoms* (fossilized diatoms) and used in water filtration to filter out solid waste in wastewater treatment plants; also used as an active ingredient in some powdered pesticides. Also referred to as *Diatomite*. (4) (Geology) A soft, fine, highly porous, yellow, light gray, or white siliceous sedimentary deposit; composed mainly of the microscopic skeletons of diatoms. It is used in water filtration; the particular shape of the diatoms in the deposit determine its filtering characteristics. Also referred to as *Kieselguhr*, *Tripolite*, *Fossil Flour*, or *Rock Meal*.

Diatomaceous Earth Filtration (DE Filtration) — A filtration method resulting in substantial particulate removal, that uses a process in which: (1) a "precoat" cake of diatomaceous earth filter media is deposited on a support membrane (septum), and (2) while the water is filtered by passing through the cake on the septum, additional filter media, known as "body feed", is continuously added to the feed water to maintain the permeability of the filter cake.

Diatomaceous Ooze — (Geology) A deep-sea, siliceous sediment consisting of more than 30 percent skeletal remains of diatoms.

Diatomite — See *Diatomaceous Earth*.

Dibromochloropropane (DBCP) — A widely used soil fumigant and potential human carcinogen that was used from 1955 until it was banned in 1977, DBCP now constitutes a severe pesticide pollution problem in agricultural areas with respect to groundwater contamination.

Diel — Of or pertaining to a 24-hour period of time; a regular daily cycle.

Differential Erosion — The more rapid erosion of one portion of the earth's surface, or of a rock mass, as compared to another.

Diffluence — A lateral branching or flowing apart of a glacier in its *Ablation* area. This separation may result from the glacier's spilling over a preglacial divide or through a gap made by basal sapping of a *Cirque* wall, or from down-valley blocking at the junction of a tributary glacier. Can be used to describe similar processes in water flow.

Diffuse Ice — Poorly defined ice edge limiting an area of dispersed ice; usually on the leeward side of an area of floating ice.

Diffuse Source Pollution (Pollutants) — See *Non-Point Source (NPS) Pollution*. Basically, diffuse pollution includes any and all water contamination that does not originate from a "point source," which is designated in the *Clean Water Act (CWA)* as pollution that can be clearly identified as a discharge from a pipe, ditch, or other well-defined source.

Diffused Air — (Water Quality) A type of aeration that forces oxygen into sewage by pumping air through perforated pipes inside a holding tank.

Diffuser — A porous plate or tube through which air is forced and divided into minute bubbles for diffusion in liquids. Commonly made of carborundum, alundum, or silica sand.

Diffusion — The movement of a substance from an area of high concentration to an area of low concentration as a result of the random movement of individual particles; the process tends to distribute them uniformly throughout the available volume. Turbulent diffusion results from atmospheric motions diffusing water, vapor, heat, and other gaseous components by exchanging parcels called eddies between regions in space in apparent random fashion.

Diffusion Coefficient — (1) The rate at which solutes are transported at the microscopic level due to variations in the solute concentrations within the fluid phases. (2) The rate of dispersion of a chemical caused by the kinetic activity of the ionic or molecular constituents. Also referred to as the *Coefficient of Molecular Diffusion*. See *Molecular Diffusion*.

Diffusivity, Soil Water — The hydraulic conductivity divided by the differential water capacity, or the flux of water per unit gradient of moisture content in the absence of other force fields.

Digester — (Water Quality) In a *Wastewater Treatment Plant*, a closed tank that decreases the volume of solids and stabilizes raw sludge by bacterial action.

Digester Gas — The gas produced as a result of the microbial decomposition of particulate organic matter under *Anaerobic* conditions. Methane and hydrogen are major components.

Digestion — (General) The biochemical decomposition of organic matter, resulting in partial gasification, liquefaction, and mineralization of pollutants. (Water Quality) In wastewater treatment, the biological decomposition of organic matter in sludge.

Dike — (1) (Engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee. (2) A low wall that can act as a barrier to prevent a spill from spreading. (3) (Groin, spur, jetty, deflector, boom) A structure designed to: (a) reduced water velocity as stream flow passes through the dike so that sediment deposition occurs instead of erosion (permeable dike), or (b) deflect erosive currents away from the stream bank (impermeable dike). (4) (Agronomy) A low ridge or bank of earth used to hold water in place during irrigation or to protect lowland areas against flooding. (5) (Geology) A tabular body of igneous (formed by volcanic action) rock that cuts across the structure of

adjacent rocks or cuts massive rocks.

Dike Ridge — (Geology) Any small, wall-like ridge produced by differential erosion, especially along the sides of a *Dike*.

Diligence — A persistent effort in the completion of a specific task, such as the construction of a water diversion project and putting water to beneficial use.

Diluent — A substance used to dilute a solution or suspension.

Dilute — To make thinner or less concentrated by adding a liquid such as water.

Dilute Solution — A solution that has been made weaker usually by the addition of water.

Dilution — The reduction of the concentration of a substance in air or water.

Dilution Factor — The extent to which the concentration of some solution or suspension has been lowered through the addition of a *Diluent*.

Dilution Ratio — (Water Quality) The ratio of the volume of water in a stream to the volume of incoming waste. The capacity of a stream to assimilate waste is reflected in the dilution ratio.

Diluvial, also Diluvian — Of, relating to, or produced by a flood.

Dimictic — Lakes and reservoirs which freeze over and normally go through two stratification and two mixing cycles within a year.

Dimictic Lake (or Reservoir) — A stratified lake or reservoir that experiences two periods of full mixing or (*Fall and Spring*) *Overturms* annually. The water in lakes layer in response to differences in the temperatures of surface and deep waters. The surface water will be warmer because of radiant heating by the sun, and the bottom water will be cooler and therefore denser. The waters in these two layers (termed the *Epilimnion* on the surface and *Hypolimnion* on the bottom) are separated by a boundary referred to as the *Thermocline*. This layering is disrupted in response to variation in air temperature associated with changes in the seasons of the year. As the epilimnion cools, it sinks, mixing the water within the lake. Contrast with *Meromictic Lake*.

Dinoflagellate — Any of numerous minute, chiefly marine protozoans of the order *Dinoflagellata*, characteristically having two flagella (a long, threadlike appendage, especially a whiplike extension of certain cells or unicellular organisms that functions as an organ of locomotion) and a cellulose covering and forming one of the primary constituents of plankton. They include bioluminescent forms and forms that produce *Red and Brown Tides*.

Dioxin — Any of several carcinogenic or teratogenic heterocyclic hydrocarbons that occur as impurities in petroleum-derived herbicides and through over-use or runoff may threaten both surface and groundwater supplies. Dioxin has been linked to cancer, damage to the immune system, and other serious health conditions. It is also produced in paper mills when chlorine is mixed with wood pulp to brighten paper. Dioxin ends up in the mills' wastewater, which is then discharged into rivers.

Dip — To plunge briefly into a liquid, as in order to wet, coat, or saturate. Synonymous with *Dunk*.

Dipper — One that dips, especially a container for taking up water.

Diquat — A strong, non-persistent, yellow, crystalline herbicide, $C_{12}H_{12}Br_2N_2$, used to control water weeds.

Direct Discharger — A municipal or industrial facility which introduces pollution through a defined conveyance or system such as outlet pipes; a point source.

Direct Filtration — (Water Quality) A method of treating water which consists of the addition of coagulant chemicals, flash mixing, coagulation, minimal flocculation, and filtration. The flocculation facilities may be omitted, but the physical-chemical reactions will occur to some extent. The sedimentation process is omitted. Also see *Conventional Filtration* and *In-Line Filtration*.

Direct Precipitation — Water that falls directly into a lake or stream without passing through any land phase of the runoff cycle.

Direct Runoff — (1) Water that flows over the ground surface or through the ground directly into streams, rivers, or lakes. (2) The runoff entering stream channels most immediately after rainfall or snowmelt. It consists of surface runoff plus interflow and forms the bulk of the *Hydrograph* of a flood. Direct runoff plus *Base Runoff* compose the entire flood hydrograph.

Direct Water Uses — Uses of water that are apparent, for example, washing, bathing, cooking, etc.

Dirt Band — (1) In a glacier, a dark layer of debris that represents the trace of a former surface. (2) A dark band below an ice wall.

Disappearance — Evaporation or transpiration of water, or its incorporation into a product (inanimate or biotic) for human use.

Disappearing Stream — See *Sinking Stream*.

Disaster Area — An area that officially qualifies for emergency governmental aid as a result of a catastrophe, such as an earthquake or a flood.

Discharge — (1) The volume of water (or more broadly, the volume of fluid including solid- and dissolved-phase material), that passes a given point in a given period of time. (2) The flow of surface water in a stream or the flow of groundwater from a spring, ditch, or flowing artesian well. (3) (Hydraulics) The rate of flow, especially fluid flow; the volume of fluid passing a point per unit time, commonly expressed as cubic feet per second, million gallons per day, gallons per minute, or cubic meters per second.

Discharge (Hydrologic) — (1) The amount of water passing a given point in a given unit of time. (2) The volume of water passing through a channel during a given time, usually measured in cubic feet per second (cfs). (3) In its simplest concept, discharge means outflow and is used as a measure of the rate at which a volume of water passes a given point. Therefore, the use of this term is not restricted as to course or location, and it can be used to describe the flow of water from a pipe or a drainage basin. With reference to groundwater, the process by which groundwater leaves the *Zone of Saturation* via *Evaporation*, *Evapotranspiration*, or by flow to the surface through springs and seeps. The data in the reports of the *U.S. Geological Survey (USGS)* on surface water represent the total fluids measured. Thus, the terms discharge, streamflow, and runoff represent water with the solids dissolved in it and the sediment mixed with it. Of these terms, discharge is the most comprehensive. The discharge of drainage basins is distinguished as follows:

[1] **Yield** — The total water runoff or "water crop" and includes runoff plus underflow;

[2] **Runoff** — That part of water yield that appears in streams; and

[3] **Streamflow** — The actual flow in streams, whether or not subject to regulation or underflow.

Each of these terms can be reported in total volumes (e.g., acre-feet) or time-related rates of flow (e.g., cubic feet per second or acre-feet per year).

Discharge Area — (1) An area in which is discharged to the land surface, surface water, or atmosphere. (2) An area in which there are upward components of hydraulic head in the aquifer. is flowing toward the surface in a discharge area and may escape as a spring, seep, or base flow, or by evaporation and transpiration.

Discharge, Average — The arithmetic average of the annual discharges for all complete water years of record whether or not they are consecutive. The term *average* is generally reserved for average of record and *mean* is used for averages of shorter periods; namely, daily mean discharge.

Discharge Coefficient — (Hydraulics) The ratio of actual rate of flow to the theoretical rate of flow through orifices, weirs, or other hydraulic structures.

Discharge Curve — A curve that expresses the relation between the discharge of a stream or open conduit at a given location and the stage or elevation of the liquid surface at or near that location. Also called *Rating Curve* and *Discharge Rating Curve*.

Discharge Formula — (Hydraulics) A formula used to calculate the rate of flow of fluid in a conduit or through an opening. For a steady flow discharge,

$$Q = A V$$

where Q is the rate of flow, A is the cross-sectional area, and V is the mean velocity. Common units are cubic feet per second.

Discharge Head — The pressure (in pounds per square inch or psi) measured at the centerline of a pump discharge and very close to the discharge flange, converted into feet.

Discharge Measurement — Total discharge is equal to the cross-sectional area of the water in a channel or pipe times its average velocity.

Discharge Period — The period of time during which effluent is discharged.

Discharge Permit — A permit issued by the state to discharge effluent into waters of the state.

Discharge Point — A location at which effluent is released into a receiving stream or body of water.

Discharge Probability Relationship — A graph of annual instantaneous peak discharge (or other hydrologic quantity) on the vertical axis, versus probability and/or recurrence interval on the horizontal axis. The graph provides a means of estimating the flow that will be reached or exceeded in a given year at a specified probability, or a means of estimating the probability that a specified discharge will be reached or exceeded in a given year.

Discharge-Rating Curve — See *Stage-Discharge Curve*.

Discharge, Sediment — The rate at which sediment passes a section of a stream or the quantity of sediment, as measured by dry weight or by volume, that is discharged in a given time.

Discharge Table — (1) A table showing the relation between two mutually dependant quantities or variable over a given range of magnitude. (2) A table showing the relation between the *Gage Height* and the *Discharge* of a stream or conduit at a given gaging station. Also called a *Rating Table*.

Discharge Velocity — An apparent velocity, calculated by *Darcy's Law*, which represents the flow rate at which water would move through an aquifer if the aquifer were an open conduit. Also referred to as *Specific Discharge*.

Discomfort Index — See *Temperature-Humidity Index*.

Discordant Junction — The joining of two streams or valleys having surfaces at markedly unequal levels.

Discount Rate — (1) The interest rate used in evaluating water (and other) capital construction and investment projects to calculate the present value of future benefits and future costs or to convert benefits and costs to a common time basis (e.g., current dollars). (2) An interest rate that takes into account the future value of dollars currently being expended. In the case of water project discount rates, the interest is figured on an annual basis for a reasonable life of the project. The discount rate recognizes the value of the potential opportunities lost into the future by tying funds up into a water project that could go to other uses. Both the interest rate selected and the length of time it is applied can greatly affect the calculated costs for a project.

Diseases (Waterborne) — See *Waterborne Diseases*.

Disembogue — To discharge or pour forth; to flow out or empty, as water from a channel.

Disinfectant — (1) A chemical or physical process that kills pathogenic organisms in water. Chlorine is often used to disinfect sewage treatment effluent, water supplies, wells, and swimming pools. (2) Any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone, that is added to water in any part of the treatment or distribution process and is intended to kill or inactivate pathogenic microorganisms. See *Water Treatment Disinfectants*.

Disinfectant and Disinfection By-Product Rule (D/DBP) — The rule promulgated by the *U.S. Environmental Protection Agency (EPA)* that would require water suppliers to reduce the levels of *Disinfection By-Products* found in treated drinking water. State 1 of the rule has been delayed until at least the year 2000 with State 2 following in 2003.

Disinfectant By-Product — A compound formed by the reaction of a *Disinfectant* such as *Chlorine* with organic material in the water supply. See *Disinfection By-Products*.

Disinfectant Contact Time ("T" in CT calculations) — The time in minutes that it takes for water to move from the point of disinfectant application or the previous point of disinfectant residual measurement to a point before or at the point where residual disinfectant concentration (C) is measured. Where only one C is measured, T is the time in minutes that it takes for water to move from the point of disinfectant application to a point before or at where residual disinfectant concentration (C) is measured. Where more than one C is measured, T is (a) for the first measurement of C, the time in minutes that it takes for water to move from the first or only point of disinfectant application to a point before or at the point where the first C+ is measured and (b) for

subsequent measurements of C, the time in minutes that it takes for water to move from the previous C measurement point to the C measurement point for which the particular T is being calculated. Disinfectant contact time in pipelines must be calculated based on plug flow by dividing the internal volume of the pipe by the maximum hourly flow rate through that pipe. Disinfectant contact time within mixing basins and storage reservoirs must be determined by tracer studies or an equivalent demonstration.

Disinfectant Time — The time it takes water to move from the point of *Disinfectant* application (or the previous point of residual disinfectant measurement) to a point before or at the point where the residual disinfectant is measured.

Disinfection — (Water Quality) (1) Water treatment which destroys potentially harmful bacteria. (2) The process designed to kill most microorganisms in water, including essentially all pathogenic (disease causing) bacteria. There are several ways to disinfect, with chlorine being most frequently used in water treatment. Compare with *Sterilization*. (3) The application of a chemical to kill most, but not all, microorganisms, that may be present. Chlorine is added to drinking water for disinfection. Disinfection makes drinking water safe to consume from the standpoint of killing pathogenic microorganisms including bacteria and viruses. Disinfection does not remove all bacteria from drinking water, but the bacteria that can survive disinfection with chlorine are not pathogenic bacteria that can cause disease in normal healthy humans. (4) The process of killing a large portion of microorganisms in or on a substance, but not bacterial spores. The primary of disinfection in water and wastewater treatment is to kill or render harmless microbiological organisms that cause disease. At the present time *Chlorination* is the most important disinfection option for drinking water treatment for the foreseeable future; however, other viable disinfection processes include *Ozonation* and *Ultraviolet Radiation (UV)*.

Disinfection (Processes) — (Water Treatment) The process by which *Raw Water* is made safe for human consumption. The process typically consists of a number of stages to include:

- [1] **Mixing/Coagulation** – This phase begins the process of *Turbidity* removal. Turbidity is the fine particulate matter that clouds water. Coagulants such as alum (aluminum sulfate) and special polymers are rapidly mixed with the water, altering the suspended particles' electrical charges and causing them to come together into larger particles, or "floc;"
- [2] **Flocculation/Sedimentation** – In this phase the floc particles continue to collide, forming ever-heavier, settleable particles. The water moves slowly through a large basin so the floc particles can sink to the bottom for removal. Anywhere from 70 to 90 percent of suspended matter is removed by sedimentation;
- [3] **Filtration** – In this process the water is "polished," further removing particles and pathogens. The water passes through a dual-media filter made of sand and anthracite coal, which traps the particles and removes odors. The filters are backwashed, or cleaned, frequently to remove accumulated matter. Nearly 100 percent of suspended matter is removed after the filtration process. Protozoan pathogens such as *Giardia* and *Cryptosporidium* are also removed during the filtration process; and
- [4] **Disinfection** – This phase is the key to destroying harmful bacteria, parasites, viruses, and other pathogens. Chlorine is used as the primary disinfectant, and chloramines (chlorine/ammonia combination) are added to maintain disinfection after the water leaves the treatment plant and enters the distribution system. Chloramines also help prevent the additional formation of disinfection byproducts.

Disinfection By-Products — (1) A compound formed by the reaction of a disinfectant such as chlorine with organic material in the water supply. Chemicals which are formed when a disinfectant such as *Chlorine* is added to water that contains organic matter, usually from decaying plant or animal material. (2) Compounds that form when chlorine combines with naturally occurring or pollution-derived organic, carbon-based materials, such as the acids from soils or decaying vegetation and bromide (salt). Total *Trihalomethanes (TTHMs)* and haloacetic acids (HAA) are by-products of the disinfection process. Such by-products are suspected to be human *Carcinogens*. One typical such disinfection by-product for which the *U.S. Environmental Protection Agency (EPA)* has established *Maximum Contaminant Levels (MCLs)* as part of its enforcement of the *Safe Drinking Water Act (SDWA)* are total Trihalomethanes (TTHMs).

Dispersant — A chemical agent used to break up concentrations of organic material such as spilled oil on a water surface.

Dispersed Demand — Demand which is distributed extensively over a wide area, the opposite of *Concentrated Demand*.

Dispersion — The spreading and mixing of chemical constituents in both surface and groundwaters caused by diffusion and mixing due to microscopic variations in densities and velocities.

Dispersion Coefficient — A measure of the spreading of a flowing substance due to the nature of the porous medium (and specific substance or fluid properties), with interconnected channels distributed at random in all directions. Also equals the sum of the *Coefficient of Mechanical Dispersion* and the *Coefficient of Molecular Diffusion* in a porous medium.

Dispersivity — A property of a porous medium (and the specific substance or fluid) that determines the dispersion characteristics of the contaminant in that medium by relating the components of pore velocity to the *Dispersion Coefficient*.

Displacement — (Geology) The distance by which portions of the same geological layer are offset from each other by a fault.

Displacement Ton — (Nautical) A unit for measuring the displacement of a ship afloat, equivalent to one long ton or about one cubic meter of salt water.

Disposal — The transference of unwanted material, such as wastes, to a new entity, a new place, or a new form.

Disposal Field — Area used for spreading liquid effluent for separation of wastes from water, degradation of impurities, and improvement of drainage waters. Also referred to as *Infiltration Field* or *Septic Tank Absorption Field*.

Disposal Pond — A small, usually diked, enclosure that is open to the atmosphere and into which a liquid waste is discharged. Also see *Lagoon*.

Disposal System — A system for the disposing of wastes, either by surface or underground methods; includes sewer systems, treatment works, disposal wells, and other systems.

Disposal Well — A deep well used for the disposal of liquid wastes.

Dissected Plateau — (Geology) A plateau that has been cut by erosion into a network of hills and valleys, but that retains its original profile.

Dissection — The partial erosional destruction of a land surface or landform by gully, arroyo, canyon or valley cutting leaving flattish remnants, or ridges, or hills or mountains separated by drainageways.

Dissociation — A chemical process that causes a molecule to split into simpler groups of atoms, single atoms, or ions. For example, the water molecule (H_2O) breaks down spontaneously into H and OH ions.

Dissoluble — That can be dissolved, e.g., dissoluble airborne pollutants brought back to the earth as rain.

Dissolve — A condition where solid particles mix, molecule by molecule, with a liquid and appear to become part of the liquid.

Dissolved — That material in a representative water sample that passes through a 0.45-micrometer membrane filter. This is a convenient operational definition used by federal agencies that collect water data. Determination of “dissolved” constituents are made on subsamples of the filtrate.

Dissolved Inorganic Nitrogen — Nitrogen primarily in the form of nitrite, nitrate, or ammonia.

Dissolved Load — All the material transported by a stream or river in solution, as contrasted with *Bed Load* and *Suspended Load*.

Dissolved Organic Carbon (DOC) — A measure of the organic compounds that are dissolved in water. In the analytical test for DOC, a water sample is first filtered to remove particulate material, and the organic compounds that pass through the filter are chemically converted to carbon dioxide, which is then measured to compute the amount of organic material dissolved in the water.

Dissolved Organic Compounds — Carbon-based substances dissolved in water.

Dissolved Oxygen (DO) — (1) Concentration of oxygen dissolved in water and readily available to fish and other aquatic organisms.

(2) The amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation. The content of water in equilibrium with air is a function of atmospheric pressure, temperature, and dissolved-solids concentration of the water. The ability of water to retain oxygen decreases with increasing temperature or dissolved solids, with small temperature changes having the more significant offset. Photosynthesis and respiration may cause diurnal variations in dissolved-oxygen concentration in water from some streams. Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms and the prevention of offensive odors. Dissolved oxygen levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life. The ideal dissolved oxygen level for fish is between 7 and 9 milligrams per liter (mg/l); most fish cannot survive at levels below 3 mg/l of dissolved oxygen. Secondary and advanced wastewater treatment techniques are generally designed to ensure adequate dissolved oxygen in waste-receiving waters.

Dissolved Oxygen (DO) Content (Level) — The amount of oxygen gas dissolved in a given volume of water at a particular temperature and pressure, often expressed as a concentration in parts of oxygen per million parts of water.

Dissolved Solids — (1) Minerals and organic matter dissolved in water. (2) The dissolved mineral constituents or chemical compounds in water or solution; they form the residue that remains after evaporation and drying. Excessive amounts of dissolved solids make water unfit to drink or use in industrial processes.

Dissolved-Solids Concentration — For water this concentration is determined either analytically by the “residue-on-evaporation” method, or mathematically by totaling the concentrations of individual constituents reported in a comprehensive chemical analysis. During that analytical determination of dissolved solids, the bicarbonate (generally a major dissolved component of water) is converted to carbonate. Therefore, in the mathematical calculation of dissolved-solids concentration, the bicarbonate value, in milligrams per liter, is multiplied by 0.4926 to reflect the change. Alternatively, alkalinity concentration (as in mg/L of $CaCO_3$) can be converted to carbonate concentration by multiplying by 0.60.

Distillate — (1) A liquid condensed from vapor in *Distillation*. (2) In the distillation of a sample, a portion is evaporated; the part that is condensed afterwards is the distillate.

Distillation — The separation of different substances in a solution by boiling off those of a lower boiling point first. For example, water can be distilled and the steam condensed back into a liquid that is almost pure water. The impurities (minerals) remain in the concentrated residue. In waste treatment, distillation consists of heating the effluent and then removing the vapor or steam. When the steam is returned to a liquid, it is almost pure (distilled) water. The pollutants remain in the concentrated residue.

Distilled Water (DW) — Water that has been purified by the *Distillation* process. Water that contains various chemicals or ions in solution is heated to boiling and the water vapor is condensed. The process leaves behind various inorganic ions and results in a water that is free of dissolved salts.

Distributary — (1) A branch of a stream which is flowing away from the main stream as frequently occurs on a delta. Contrasted with a *Tributary*. (2) A diverging stream which does not return to the main stream, but discharges into another stream or the ocean. Also refers to conduits that take water from a main canal for delivery to a farm. See *Distributary Channel* or *Stream*.

Distributary Channel (or Stream) — A river branch that flows away from a main stream and does not rejoin it. Characteristic of *Deltas* and *Alluvial Fans*.

Distribution (of Water) — The management of water which allows water users to receive the amount of water to which they are entitled by law and as supply permits.

Distribution Coefficient — The quantity of a solute absorbed per unit weight of a solid divided by the quantity dissolved in water per unit volume of water.

Distribution Graph (Distribution Hydrograph) — A *Unit Hydrograph* of direct runoff modified to show the portion of the volume of runoff that occurs during successive equal units of time.

Distribution System — (1) Any combination of pipes, tanks, pumps, and so forth that delivers water from water sources or treatment facilities to the consumer. (2) (Irrigation) A system of ditches and their appurtenances which convey irrigation water from the main canal to the farm units; diverse water from the main canal-side turnout to individual water users or to other smaller

distribution systems. (3) Any system that distributes water within a farm.

Distribution Uniformity (DU) — (1) Generally, a term used to describe how evenly water is applied on a field and therefore a practical method for measuring the performance of an irrigation system. The concept of distribution uniformity constitutes one of the limiting factors on a system's *Irrigation Efficiency (I.E.)*. (2) Also, a ratio used to measure the infiltration of irrigation water through a given soil profile. More specifically, the ratio of the average low-quarter depth of irrigation to the average depth of irrigation, for the entire farm field, expressed as a percent. Typically, a DU of between 80 and 90 percent is considered very good.

District [USBR] — An entity that has a contract with the *U.S. Bureau of Reclamation (USBR)* for the delivery of irrigation water. Such entities include, but are not limited to: canal companies, conservancy districts, ditch companies, irrigation and drainage districts, irrigation companies, irrigation districts, reclamation districts, service districts, storage districts, water districts, and water users associations.

Disturbance — A discrete event or process which kills or removes vegetation. From an ecological and hierarchical perspective, disturbance is a change in the minimal structure of an ecosystem caused by a factor external to the reference structure, for example, fire, activities by man, etc.

Disturbed Area — (Geology) Area where vegetation, topsoil, or overburden has been removed, or where topsoil, spoil, and processed waste has been placed.

Ditch — A long narrow trench or furrow dug in the ground, as for irrigation, drainage, or a boundary line.

Ditch Rider — An individual responsible for operating structures and distributing water internally within an irrigation project. Canal system operations personnel. The person or persons responsible for controlling the canal system based on the flow schedule established by the *Watermaster*.

Diurnal Tide — (Oceanography) A tide consisting of only one low water and one high water during a lunar day.

Divalent — Having a valence of two, such as the ferrous ion, Fe_2^+ .

Dive — To plunge, especially headfirst, into water.

Divergence — (1) A movement of water away from a central point or path. (2) (Oceanography) A horizontal flow of water outward from a common center or zone, often associated with upwelling. (3) (Meteorology) A meteorological condition characterized by the uniform expansion in volume of a mass of air over a region, usually accompanied by fair dry weather.

Divergent Plate Boundary — In the theory of *Plate Tectonics*, a boundary between two plates that make up the crust of the earth. The boundary is characterized by a chasm between the two plates, filled with molten rock from within the earth.

Diversion — (1) Use of part of a stream flow as a water supply. (2) A structural conveyance (or ditch) constructed across a slope to intercept runoff flowing down a hillside, and divert it to some convenient discharge point. (3) A structure in a river or canal that divers water from the river or canal to another watercourse. (4) The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system. Also, a turning aside or alteration of the natural course of a flow of water, normally considered physically to leave the natural channel. In some states, this can be a consumptive use direct from a stream, such as by livestock watering. In other states, a diversion must consist of such actions as taking water through a canal or conduit.

Diversion Channel — (1) An artificial channel constructed around a town or other point of high potential flood damages to divert floodwater from the main channel to minimize flood damages. (2) A channel carrying water from a diversion dam.

Diversion Dam (and Dike) — A barrier built to divert part or all of the water from a stream into a different course. The diversion dam is commonly constructed on a natural river channel and is designed to check or elevate the water level for diversion into a main canal system. Also referred to as *Diversion Cofferdam*.

Diversion Entitlements — The maximum amount of water which may be diverted or withdrawn from a water source for a particular purpose over a given period of time. Historical appropriation of diversionary water entitlements is based on priority or seniority, i.e., those who made use of the water first have historical priority to use it first. The water appropriation system is primarily concerned with making sure that water entitlements are received in the order of seniority. Making sure that senior water rights holder do not exceed their diversion entitlements serves to protect junior entitlements as well as downstream users.

Diversion Point — The geographic location at which water is diverted for purposes of placing the water to beneficial use. Examples of diversion points include wells, water storage dams, diversion dams, dugouts, pump sites along a surface water source, etc.

Diversion Rate — A rate of water flow (cfs) diverted into a canal or through a farm headgate.

Diversity Index — A numerical expression of the evenness of distribution of aquatic organisms. Several different formulae are in current use for its calculation. One such formula for the diversity index is expressed as

$$d = - \sum_{i=1}^s G \frac{n_i}{n} \log_2 \frac{n_i}{n} \text{ where the summation ranges from } i = 1 \text{ to } s$$

where n_i is the number of individuals per taxon, n is the total number of individuals, and s is the total number of taxa in the sample of the community. Diversity index values range from zero, when all the organisms in the sample are the same, to some positive number, when some or all of the organisms in the sample are different.

Divertible Water Supply — Includes that amount of water consumptively used and that water which returns to the river system. Since return flow becomes available for subsequent diversion and reuse, the total divertible supply is greater than the available supply.

Divide — An imaginary line indicating the limits of a sub-basin, sub-watershed, or watershed; the boundary line along a topographic ridge or high point which separates two adjacent drainage basins. Also referred to as *Ridge Lines*.

Diving Reflex — A reflexive response to diving in many aquatic mammals and birds, characterized by physiological changes that decrease oxygen consumption, such as slowed heart rate and decreased blood flow to the abdominal organs and muscles, until

breathing resumes. Though less pronounced, the reflex also occurs in certain non-aquatic animals, including human beings, upon submersion in water.

Divining Rod — A forked branch or stick that is believed to indicate subterranean water or minerals by bending downward when held over a source. Also see *Douse* (also *Dowse*).

Division Box — (Irrigation) A structure used to divide and direct the flow of water between two or more irrigation ditches.

(State) Division of Health [Nevada] — An agency within the Department of Human Resources, State of Nevada, whose primary water-related mandate (Nevada Revised Statutes 445.361) is “to provide water which is safe for drinking and other domestic purposes and thereby promote the public health and welfare.” The Division serves as the primacy agency for the *Public Water System Supervision Program (PWSSP)* as authorized under the federal *Safe Drinking Water Act (SDWA)* [Public Law 93–523] and its amendments. The Division implements State Board of Health regulations which address drinking water monitoring and quality, public water system construction, and public water system operator certification. To accomplish its tasks, the Division consists of a number of Boards and Bureaus, to include:

- [1] **State Board of Health** — Advises the Health Division Administrator on matters relating to public health and welfare.
- [2] **State Health Officer** — Primary state adviser on matters pertaining to medical health; oversees the activities of the Bureau of Laboratory Services, Bureau of Community Health Services, Bureau of Family Health Services, Bureau of Disease Control and Intervention Services, and the Bureau of Health Planning.
- [3] **Bureau of Health Protection Services** — Provides for safe drinking water, health engineering, sanitation (food, dairy, drugs and cosmetics), and radiological health matters.
- [4] **Bureau of Laboratory Services** — Microbiology lab, chemistry lab, research and testing on community water systems.
- [5] **Bureau of Community Health Services** — Family planning, community health nursing, and clinic services.
- [6] **Bureau of Family Health Services** — Genetics, special children’s clinic, children’s dental services, newborn screening, and health promotion and education.
- [7] **Bureau of Health Planning** — State health plan, primary care development center, state center for health statistics, tobacco control initiative.
- [8] **Bureau of Disease Control and Intervention Services** — Programs dealing with surveillance, immunization, TB control.
- [9] **Bureau of Licensure and Certification** — Programs dealing with health facilities, laboratory personnel certification, emergency medical services and trauma.
- [10] **Bureau of Administrative Services** — Fiscal management, personnel, affirmative action, legal services, vital records, and cancer registry.

DO — See *Dissolved Oxygen (DO)*.

DOC — See *Dissolved Organic Carbon (DOC)*.

Dock — (1) The area of water between two piers or alongside a pier that receives a ship for loading, unloading, or repairs. (2) A pier; a wharf. (3) Often docks: A group of piers on a commercial waterfront that serve as a general landing area for ships or boats.

“Docking” (of Water Rights) — The temporary transfer of control of water rights so that water permitting authorities will not revoke the rights because the water has not been put to beneficial use within a certain time limit as required. To dock the water rights, the holder would typically file a “Change of Point of Diversion and Change in Point of Use” application to be approved by the State Engineer or other water permitting authority. When the water is needed by the water right holder, another application would be filed to return the water rights to their original point of diversion.

Dockyard — An area, often bordering a body of water, with facilities for building, repairing, or dry-docking ships.

Doctrine — A particular principle or tenet that is presented for acceptance or belief, such as the *Public Trust Doctrine*.

Doctrine of Mutual Prescription [California] — A concept developed by the California Supreme Court in 1949 in the case of *Pasadena v. Alhambra*. The court decided that various users of water in chronically overdrafted groundwater basins, including overlying (*Overlying Water Right*) and appropriators, had acquired prescriptive rights, that is, rights to infringe upon the established water rights of others by means of trespass or unauthorized taking. These prescribers were awarded a proportional share of the basin’s total supply. In this case, the total extraction amount was limited to a basin’s safe yield, or perennial recharge, with rights to use the groundwater based upon demonstrated use over the last five years of pumping.

Doctrine of Relation [Nevada] — A water rights concept which means that a water priority is claimed as of the date of appropriation for the amount appropriated, even though a part of it may not have been put to beneficial use until a later date. More specifically, to secure the benefit of the doctrine of relation, there must be posted a notice of appropriation (which must be recorded), there must be a bona fide intention to use the water for a beneficial purpose, there must be diligence in the construction work, and the work must be completed (i.e., the waters conducted to the place of intended use). Actual application of the water is not a prerequisite to the vesting of the right. The right is complete when possession has been taken. When these requisites have been completed the right to the water relates back to the date of posting notice, in order to determine priority between conflicting claims.

Doctrine of Reliction [Nevada] — In a Nevada Supreme Court ruling (*State Engineer v. Cowles Bros.*, 86 Nev. 872, 1964) it was held that the lands so exposed by *Reliction*, i.e., those lands exposed by the recession of a body of water, should belong to the adjoining land owners. This held true even for those lands exposed by the recession of a navigable body of water, whose bed is owned by the State of Nevada (e.g., Winnemucca Lake). Also see *Dereliction*.

Doldrums — (1) A region of the ocean near the equator, characterized by calm, light winds, or squalls. (2) The weather conditions

characteristic of these regions of the ocean.

Dollop — A small quantity or splash of a liquid.

Dolos — A concrete protective unit used to dissipate wave energy thus preventing damages to breakwaters and jetties. Units may vary in size and weight depending on design wave parameters.

Domestic Consumption — Water used for household purposes such as washing, food preparation, toilets and showers. It is the quantity, or quantity per capita (person), of water consumed in a municipality or district for domestic uses or purposes during a given period. It sometimes encompasses all uses, including the quantity wasted, lost, or otherwise unaccounted for. Also referred to as *Domestic Use*.

Domestic Contribution — Wastes originating in a residential facility or dwelling. In this use, it means the type and quantity of wastes are different from commercial and industrial or agricultural wastes.

Domestic or Other Non-Distribution System Plumbing Problem — A coliform contamination problem in a public water system with more than one service connection that is limited to the specific service connection from which the coliform positive sample was taken.

Domestic Sewage — Wastewater and solid waste that is characteristic of the flow from toilets, sinks, showers, and tubs in a household. Also referred to as *Domestic Waste*.

Domestic Use — Use of water by an individual, or by a family unit or household, for drinking, washing, sanitary and culinary purposes and other ordinary household purposes; irrigation of a noncommercial family garden, trees, shrubbery or orchard not greater in area than one acre. Also see *Domestic Consumption*.

Domestic Wastewater Facility — Refers to those facilities that receive or dispose of wastewater derived principally from residential dwellings, business or commercial buildings, institutions, and the like. May also include some wastewater derived from industrial facilities. Also referred to as *Municipal Wastewater Facility*.

Domestic Water — Water supplied to individual dwellings and other land uses which is suitable for drinking.

Domestic Water Use (Withdrawals) — Water used normally for residential purposes, including household use, personal hygiene, drinking, washing clothes and dishes, flushing toilets, watering of domestic animals, and outside uses such as car washing, swimming pools, and for lawns, gardens, trees and shrubs. The water may be obtained from a public supply or may be self supplied. The terms “water use” and “water withdrawals” are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also referred to as *Residential Water Use*. Also see *Public Water Supply System* and *Self-Supplied Water*.

Domestic Well — A water well used solely for domestic, i.e., residential or household purposes to include both indoor and outdoor water uses. Such wells are generally not required to be permitted; however, they may have restrictions in terms of daily pumping amounts, for example, 1,800 gallons per day.

Dominant Discharge — The channel-forming discharge, which is equivalent to the bankfull discharge, responsible for the active channel that erodes and deposits, creates pools, riffles, and meanders. The discharge, in terms of flood frequency, usually has a return period or recurrence interval of 1.5 to 2 years in natural channels. This represents a flow condition where the stream flow completely fills the stream channel up to the top of the bank before overflowing onto the floodplain.

Dormancy — Annual period when a plant’s growth processes greatly slow down. This occurs in many plants by the coming of winter as days grow shorter (sunlight hours) and temperatures grow colder.

Dormant — Unexercised, not active but capable of becoming exercised, as a dormant riparian right to use water.

Dosage — The quantity of a chemical administered to an organism.

Dose — The actual quantity of a chemical to which an organism is exposed. See *Absorbed Dose*.

Dose-Response — A quantitative relationship between the dose of a chemical and an effect caused by the chemical.

Dose-Response Curve — A graphical presentation of the relationship between degree of exposure to a chemical (dose) and observed biological effect or response.

Dose-Response Evaluation — A component of risk assessment that describes the quantitative relationship between the amount of exposure to a substance and the extent of toxic injury or disease.

Dose-Response Relationship — The quantitative relationship between the amount of exposure to a substance and the extent of toxic injury produced.

Double Check Valve — Two single check valves coupled within one body and furnished with test cocks and two tightly closing gates valves used to protect against both *Back-Siphonage* and *Backpressure* conditions.

Double Cropping — The practice of producing two or more crops consecutively on the same parcel of land during a 12-month period. Also more generally referred to as *Multi-Cropping*.

Douche — A stream of water, often containing medicinal or cleansing agents, that is applied to a body part or cavity for hygienic or therapeutic purposes.

Douglas Scale — (Oceanography) One of two series of numbers from 0 to 9 that are used to define the degree of disturbance of the ocean surface.

Douse, also Dowse — (1) To plunge into liquid; to immerse and wet thoroughly. (2) To use a *Divining Rod* to search for underground water or minerals, as in *Dowsing*.

Downfall — A fall of rain or snow, especially a heavy or unexpected one.

Downgradient — The direction that groundwater flows; similar to “downstream” for surface water flows.

Downgradient Well — One or more monitoring wells placed to sample groundwater that has passed beneath a facility with the potential to release chemical contaminants into the ground. Results of testing downgradient well water are compared with data from an *Upgradient Well* to determine whether the facility may be contaminating the groundwater.

Downpour — A heavy fall of rain.

Downstream — (1) In the direction of the current of a stream. (2) Away from the source of a stream. Used similarly to *Downriver*. (3) More generally, the direction toward which a fluid is moving, implying the horizontal component of the direction of the basic stream.

Downstream Control — (Irrigation) Control structure adjustments which are based on information from downstream; the required information is measured by a sensor located downstream or based on the downstream water schedule established by the *Watermaster*.

Downstream Slope (of a Dam) — The slope or face of the dam away from the reservoir water, which, for *Embankment Dams*, requires some form of protection such as grass to protect it from the erosive effects of rain and surface flows.

Downstream Toe of Dam — The junction of the downstream face of a dam with the ground surface. For an *Embankment Dam* the junction of the upstream face with the ground surface is the upstream toe.

Dowser — (1) A person who uses a *Divining Rod* to search for underground water or minerals. (2) A divining rod.

DPD — A method of measuring the chlorine residual in water. The residual may be determined by either titrating or comparing a developed color with color standards. DPD stands for N,N-diethyl-p-phenylene-diamine.

Draft — (1) The act of drawing or removing water from a tank or reservoir. (2) The water which is drawn or removed. (3) (Nautical) The depth of a vessel's keel below the water line, especially when loaded.

Drag — To search or sweep the bottom of a body of water, as with a grappling hook or dragnet.

Drain — (1) To draw off (a liquid) by a gradual process. (2) A buried pipe or other conduit (closed drain) for the conveyance of surplus groundwater. (3) A ditch or canal (open drain) for carrying off surplus surface water or groundwater. (4) A system to control water tables near the ground surface to maintain levels at or below specified depths.

Drainage — (1) The removal of excess surface water or groundwater from land by means of surface or subsurface drains. (2) Improving the productivity of agricultural land by removing excess water from the soil by such means as ditches or subsurface drainage tiles (pipes); surface drainage is accomplished with open ditches; subsurface drainage uses porous conduits (drain tile) buried beneath the soil surface. (3) The downward movement of water through the soil. When this occurs rapidly, the soil is referred to as "well drained"; otherwise poorly drained. Most plant roots need oxygen as well as water, and soil that remains saturated (poorly drained) deprives roots of necessary oxygen. (4) Soil characteristics that affect natural drainage.

Drainage Area (of a Stream at a Specified Location) — That area, measured in a horizontal plane, enclosed by a topographic (drainage) divide from which direct surface runoff from precipitation or snowpack runoff normally drains by gravity into the stream above the specified point.

Drainage Basin — (1) The land area drained by a river. (2) The area of land from which water drains into a river, for example, the Sacramento River Basin, in which all land area drains into the Sacramento River. (3) Part of the earth's surface that is occupied by a drainage system with a common outlet for its surface runoff. (4) Part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water. (5) An area occupied by a closed drainage system, especially a region that collects surface water runoff and contributes it to a stream channel, lake, or other body of water. (6) The area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel. The term is used synonymously with *Watershed*, *River Basin*, *Catchment*, *Catchment Area*, or *Catchment Basin*.

Drainage Class, Soils — The relative terms used to describe natural drainage and corresponding types of soils are as follows:

- [1] **Excessive** — Excessively drained soils are commonly very porous and rapidly permeable, and have low water-holding capacity;
- [2] **Somewhat Excessive** — Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile;
- [3] **Good** — Well drained soils that are nearly free of mottling and are commonly of intermediate texture;
- [4] **Moderately Good** — Moderately well drained soils that commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the surface layers and upper subsoil, and mottling in the lower subsoils and substrata;
- [5] **Somewhat Poor** — Somewhat poorly drained soils are wet for significant periods, but not all the time. They commonly have a slowly permeable layer in their profile, a high water table, additions through seepage, or a combination of these conditions;
- [6] **Poor** — Poorly drained soils are wet for long periods of time. They are light gray and generally are mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Drainage Coefficient — Design rate at which water is to be removed from a drainage area.

Drainage Composition — A quantitative description of a given drainage basin in terms of its drainage density, stream order, bifurcation ratio, and stream-length ratio.

Drainage Density — (1) The relative density of natural drainage channels in a given area, obtained by dividing the total length of the stream channels by the area. (2) The length of all channels above those of a specified *Stream Order* per unit of *Drainage Area*.

Drainage District — A special purpose district created under state law to finance, construct, operate, and maintain a drainage system involving a group of land holdings.

Drainage Divide — The line of highest elevations which separates adjoining drainage basins. See *Divide* or *Water Divide*.

Drainage Field Ditch — A shallow graded ditch for collecting excess water within a field, usually constructed with flat side slopes for ease of crossing.

Drainage Flooding — Ponding of water at or near the point where it fell due to improper or limited drainage.

- Drainage Lake** — Any lake having a surface outlet through which it loses water.
- Drainage Lateral** — A side ditch or conduit which contributes water to a drainage main.
- Drainage Layer (or Blanket)** — (Dam) A layer of permeable material in a dam to relieve pore pressure or to facilitate drainage of fill material.
- Drainage Main** — A natural or artificial ditch or conduit for moving water off the land.
- Drainage Pattern** — The arrangement or configuration of the natural stream courses in any given area when projected onto a flat surface. Also referred to as a *Drainage Network*.
- Drainage Ratio** — The ratio between the amount of runoff in a given area during a given period of time and the amount of precipitation in that area during the same time period. Also referred to as *Discharge Efficiency*.
- Drainage System** — (1) A natural system by which a region is drained, consisting of a body of enclosed surface water, such as a stream, together with all other such bodies of water that are tributary to it. (2) An artificial system, including the surface and subsurface conduits, that drains a region.
- Drainage Water** — The water which has been collected by a drainage system. It may come from surface water or from water passing through the soil. It may be of a quality suitable for reuse or it may be of no further economic use.
- Drainage Well** — (Irrigation) A vertical opening to a permeable substation into which surface and subsurface water is channeled. A well drilled to carry excess water off agricultural fields. Because they act as a funnel from the surface to the groundwater below, drainage wells can contribute to groundwater pollution.
- Drain Field** — A network of buried piping or tubing where the fluid is discharged to the ground through seepage. Most common use is with septic tanks, but can also be used for domestic or industrial wastewater disposal after other treatment methods.
- Drainpipe** — A pipe for carrying off water or sewage.
- Drains (of a Dam)** — A vertical well or borehole, usually downstream of impervious cores, grout curtains, or cutoffs, designed to collect and direct seepage through or under a dam to reduce uplift pressure under or within the dam. A line of such wells forms a drainage curtain. Also referred to as *Relief Wells*.
- Drainwater** — Any water which flows from an irrigation project for which there is no claim to satisfy an agricultural water right.
- Draw** — To cause to flow forth as a pump drawing water.
- Drawdown** — (1) The act, process, or result of depleting, as a liquid or body of water as in the lowering of the water surface level due to release of water from a reservoir. (2) The vertical distance ground-water elevation is lowered, or the amount head is reduced, due to the removal (pumping) of groundwater. (3) The distance by which the water level of a reservoir or other body of water is lowered as a result of the withdrawal of water. (4) The difference in levels between the static water level and the pumping or dynamic water level in a well. (5) The magnitude of lowering of the surface of a body of water or of its *Piezometric Surface* as a result of withdrawal of the release of water therefrom. (6) The decline of water below the static level during pumping. (7) (Water Table) The lowering of the elevation of the *Groundwater Table*, usually from pumping wells, but can occur naturally during periods of prolonged drought. At the well, it is the vertical distance between the static and the pumping level.
- Dredge** — To clean, deepen, or widen with a mechanical scoop. See *Dredging*.
- Dredging** — (1) A method for deepening streams, swamps, or other waters by scraping and removing solid materials from the bottom. Such actions can disturb the *Ecosystem* and cause silting that kills aquatic life. Dredging of contaminated muds can expose *Biota* to heavy metals and other toxic substances. (2) The process of digging up an removing material from wetlands or from the bottoms of waterways to clear them or make them deeper or wider. For example, tidal creeks in salt marshes are often dredged to make them wide enough for boat passage. Dredging and activities associated with it can damage wetlands. Dredging activities may be subject to regulation under *Section 404* of the *Clean Water Act (CWA)*.
- Dreg** — The sediment in a liquid; lees. Often used in the plural.
- Drench** — To wet through and through; soak.
- DRI [Nevada]** — See *Desert Research Institute (DRI) [Nevada]*.
- Dribble** — To flow or fall in drops or an unsteady stream; trickle.
- Dribblet** — A tiny falling drop of liquid.
- Drift** — To be carried along by currents of air or water.
- Drift Current** — (Oceanography) A broad, slow-moving *Ocean Current* caused by wind.
- Drift Ice** — (Oceanography) Ice that has drifted away from its place of origin.
- Drift Lake** — A *Glacial Lake* that occupies a depression in the surface of glacial drift after the ice has all melted.
- Drift Organisms** — *Benthic* organisms temporarily suspended in the water and carried downstream by the current.
- Drift Sheet** — A sheet-like deposit of *Glacial Drift* laid down during a single glaciation or during a series of closely related *Glaciations*.
- Drift Terrace** — See *Alluvial Terrace*.
- Driftage** — (1) (Nautical) Deviation from a set course caused by drifting. (2) Matter that has been carried along or deposited by air or water currents.
- Drill Collar** — A length of extremely heavy steel tube. It is placed in the drill string immediately above the drill bit to minimize bending caused by the weight of the drill pipe.
- Drill Pipe** — Special pipe used to transmit rotation from the rotating mechanism to the bit. The pipe also transmits weight to the bit and conveys air or fluid which removes cuttings from the hole and cools the bit.
- Driller's Well Log** — A log kept at the time of drilling showing the depth, thickness, character of the different strata penetrated, location of water-bearing strata, depth, size, and character of casing installed.
- Drilling Fluid** — A water- or air-based fluid used in the water-well drilling operation to remove cuttings from the hole, to clean and cool the bit, to reduce friction between the drill string and the sides of the hole, and to seal the borehole.

Drilling Mud — A mixture of clay, water, and other materials, often bentonite clay and barite, commonly used in drilling with a rotary drill rig. The mud is pumped down the drill pipe and through a drill bit and back up to the surface between the drill pipe and the walls of the hole. The mud helps lubricate and cool the drill bit as well as carry the cuttings to the surface. The mud also stabilizes the hole. Also referred to as *Drilling Fluid*.

Drink — (1) To take into the mouth and swallow a liquid such as water. (2) To take in or soak up; absorb.

Drinkable — Suitable or fit for drinking; *Potable*.

Drinking Water — (1) Any fresh water that is suitable for drinking; in general, water with less than 500 milligrams per liter (mg/L) of undissolved solids. (2) A term used synonymously with *Potable Water*, and refers to water that meets federal drinking water standards of the *Safe Drinking Water Act [SDWA]* (*Public Law 93–523*) as well as state and local water quality standards and is considered safe for human consumption. Freshwater that exceeds established standards for chloride content and dissolved solids limits is often referred to as slightly saline, brackish, or nonpotable water and is either diluted with fresher water or treated through a desalination process to meet drinking-water standards for public supply.

Drinking Water Equivalent Level (DWEL) — (1) Protective level of exposure related to potentially non-carcinogenic effects of chemicals that are also known to cause cancer. (2) Estimated exposure (in mg/L) which is interpreted to be protective for non-carcinogenic endpoints of toxicity over a lifetime of exposure. DWEL was developed for chemicals that have a significant carcinogenic potential (Group B). Provides risk manager with evaluation on non-cancer endpoints, but infers that carcinogenicity should be considered the toxic effect of greatest concern.

Drinking Water Priority List (DWPL) — A list of known and potential contaminants in drinking water. The list is updated every four years using results from unregulated contaminant monitoring. The *Safe Drinking Water Act (SDWA)* Amendments of 1986 mandate the EPA to regulate 25 contaminants from this list every three years.

Drinking Water Standards — Drinking water standards established by state agencies, the U.S. Public Health Service, and the U.S. Environmental Protection Agency (EPA) for drinking water throughout the United States.

Drinking Water Standards [Nevada] — The primary objective of Nevada's drinking water standards is to assure safe water for human consumption. To this end, the *Nevada Department of Human Resources, Health Division — Consumer Health Protection* has established statewide primary and secondary drinking water standards at least as rigorous as those required by the U.S. Environmental Protection Agency (EPA). *Primary Drinking Water Standards* limit contaminants (constituents) which may affect consumer health. *Secondary Drinking Water Standards* were developed to deal with the aesthetic qualities of drinking water.

Drinking Water Supply — Water provided for use in households. The most common sources are from surface supplies (rivers, lakes, and reservoirs) or subsurface supplies (aquifers). The distribution of water to households is regulated under the *Safe Drinking Water Act (SDWA)* of 1974, as amended.

Drip — (1) To fall in drops; to shed drops; to ooze or become saturated with or as if with liquid. (2) Any slight or intermittent flow of water. (1) Water that has collected on and falls from leaves, twigs, and so on.

Drip Irrigation — (1) A system for watering at points on or just below the soil surface so that a plant's *Root Zone* is thoroughly moistened without water being wasted. The irrigation is accomplished with very low pressure over a long period of time to achieve necessary soil penetration of water. (2) A planned irrigation system in which water is applied directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure. The applicators may be placed on or below the surface of the ground. Also see *Irrigation Systems*.

Drip (Trickle) Soil Absorption System — A shallow slow rate pressure-dosed system used for land application of treated wastewater, particularly under soil conditions unsuitable for normal septic tanks and gravity-fed soil absorption systems. In agriculture, drip soil irrigation systems irrigate crops by means of a network of shallow underground pipes fed by a pump. Such a system conserves water used in crop irrigation by applying it at a controlled rate in the root zone, minimizing evaporation and percolation losses. In the drip soil absorption system, the filtered effluent is delivered via supply lines to a subsurface drip field consisting of parallel rows of polyethylene tubing, known as dripper lines. Emitters are installed along these tubes to uniformly distribute and control the flow of effluent. The key to the effective operation of drip soil absorption systems is the slow and controlled rate at which it applies effluent over a large surface area, allowing relatively shallow placement of the dripper lines and long-term use without risk of saturating soils. This allows such systems to be effectively used for subsurface irrigation of trees, shrubs, and gardens in arid regions. Also see *Septic Tank Soil Absorption System (ST-SAS)*.

Drive Point — See *Well Point*.

Driven Well — A well constructed in an unconsolidated formation by driving the casing from the ground surface to the final casing depth as the well is deepened.

Drizzle — (1) Very small water drops that precipitate at a rate usually less than 0.04 in (1 mm) per hour. (2) Rather uniform precipitation consisting exclusively of minute and very numerous drops of water less than 0.02 inches (0.51 mm) in diameter, which seem to float in and follow even the slightest motion of the air. Poor visibility during drizzle, which frequently occurs simultaneously with fog, distinguishes it from light rain.

Drop — (1) (River) An abrupt descent in a river. A downward pitch river flow. (2) (Measurement) The quantity of fluid which falls in one spherical mass; a liquid globule; often, a teardrop, raindrop, dewdrop, etc. The size of a drop varies with the specific gravity and viscosity of the liquid and also with the conditions under which it is formed.

Drop-Inlet Spillway — Overfall structure in which the water drops through a vertical riser connected to a discharge conduit.

Drop Spillway — An overfall structure in which water drops over a vertical wall onto a protected apron at a lower elevation.

Droplet — A small airborne liquid particle that is larger than liquid aerosol and therefore settles out of the atmosphere relatively quickly.

Dropper — A small tube with a suction bulb at one end for drawing in a liquid and releasing it in drops.

Drops — Structures to reduce or control water velocity within an irrigation ditch or canal by lowering the water abruptly from one

level to a lower level.

Drop Spillway — An overfall structure in which water drops over a vertical wall onto a protected apron at a lower elevation.

Drop Structure — A structure for dropping water to a lower level and dissipating its surplus energy. A drop may be vertical or inclined.

Drought — There is no universally accepted quantitative definition of drought. Generally, the term is applied to periods of less than average or normal precipitation over a certain period of time sufficiently prolonged to cause a serious hydrological imbalance resulting in biological losses (impact flora and fauna ecosystems) and/or economic losses (affecting man). In a less precise sense, it can also signify nature's failure to fulfill the water wants and needs of man. The following are three broad categories of drought:

- [1] **Meteorological Drought** — Such a drought is considered to occur when annual rainfall (or precipitation) is less than the long-term average annual rainfall;
- [2] **Hydrological Drought** — The onset of such a drought is signified by the occurrence and/or persistence of meteorological drought causing shortage of surface water in streams, lakes, reservoirs and/or groundwater supplies;
- [3] **Agricultural Drought** — This type of drought occurs when soil moisture availability to agricultural crops is reduced to a level causing adverse effects on grain yield and consequently, the agricultural production of a region.

See *Drought Indexes*.

Drought Condition — Hydrologic conditions during a defined *Drought* period during which rainfall and runoff are much less than average.

Drought Indexes (Indices) — An indicator of drought, or below-normal precipitation conditions. Drought indexes, based on raw data inputs, are most typically represented as numeric values and are useful for planning and decision-making. The drought index may be useful not only in comparing precipitation over different time periods, but in some cases the indexes can also provide comparative analysis between different geographic and climatologic areas. The drought index is intended to provide an indication of a period's precipitation conditions relative to an average or standard value, frequently referred to as "normal" or "near normal" conditions. A number of drought indexes have been developed over time for specific conditions. While no one drought index is inherently superior to the rest under all conditions and circumstances, some are better suited than others for particular uses. For example, some drought indexes may be better when working with relatively uniform topography, while others may specifically take snowpack conditions into account and therefore be better suited for mountainous regions with complex regional microclimates. Some of the most widely used drought indexes include:

- [1] **Percent of Normal** — One of the simplest measurements of rainfall for a location, a percent of "normal" figure is calculated by dividing the actual period precipitation by the normal precipitation, which is typically based on a historical average of a 30-year mean or average value. This figure is then multiplied by 100 percent to provide the drought index value. Normal precipitation for a specific location is always considered to be 100 percent; therefore, drought index numbers below 100 percent indicated various degrees of drought conditions. The percent of normal index, while easily understood and effective for assessing a single region or season, can be misunderstood as the concept of normal is a mathematical construct and does not necessarily correspond with what one should expect precipitation to be in any given year (i.e., the normal value may be merely an average of extreme conditions).
- [2] **Standardized Precipitation Index (SPI)** — A precipitation index based on the probability of precipitation for any time duration. The SPI was specifically designed to quantify the precipitation deficit for multiple periods of time reflecting the impact of drought on the availability of different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale, while groundwater, stream flow and reservoir storage levels reflect the longer-term precipitation anomalies. For this reason, the SPI is calculated on both a short-term and long-term (up to four years) basis. Positive SPI values indicate greater than median (middle-most) precipitation, while negative values indicate less than median precipitation. Because the index is normalized, wetter and drier climates can be determined in the same way. A drought event occurs any time the SPI is continuously negative and reaches an intensity where the SPI is -1.0 or less. SPI indexes range as follows:

SPI Measure	Drought Condition
2.0 or greater	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2.0 or less	Extremely dry

- [3] **Palmer Drought Severity Index (PDSI)** — The PDSI was the first comprehensive drought index developed in the United States. It is a meteorological drought index based on a balance between moisture supply and demand and responds to weather conditions that have been abnormally dry or abnormally wet. The index is calculated based on precipitation and temperature data, as well as the local *Available Water Content (AWC)* of the soil, i.e., soil moisture. From the index's inputs, all the basic terms of the water balance equation can be determined, including

evapotranspiration, soil recharge, runoff, and moisture loss from the surface layer. The index, however, is less well suited for mountainous regions or areas of frequent climatic extremes. Human impacts on the water balance, such as irrigation or drainage, are not considered. The index roughly ranges from extremes of -6 to +6, with negative values denoting dry spells and positive values indicating wet periods. There are also a few values in the magnitude of -7 or +7. Ideally, the PDSI is designed so that a -4.0 in South Carolina has the same meaning in terms of the moisture departure from a climatological normal as a -4.0 in Idaho. The following table shows the more typical PDSI classifications:

Palmer Drought Index	Drought Condition
4.00 or more	Extremely wet
3.00 to 3.99	Very wet
2.00 to 2.99	Moderately wet
1.00 to 1.99	Slightly wet
0.50 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.50 to -0.99	Incipient dry spell
-1.00 to -1.99	Mild drought
-2.00 to -2.99	Moderate drought
-3.00 to -3.99	Severe drought
-4.00 or less	Extreme drought

- [4] **Crop Moisture Index (CMI)** – The CMI, as a derivative of the *Palmer Drought Severity Index (PDSI)*, uses a meteorological method to monitor week-to-week crop conditions. Differing from the PDSI, the CMI was designed to evaluate short-term moisture conditions across major crop-producing regions. It is based on the mean temperature and total precipitation for each week within a “climate division”, as well as the CMI value from the previous week. The CMI is specifically designed to monitor short-term moisture conditions affecting a developing crop and is not a good long-term drought monitoring tool. The CMI was designed for areas in which mountain snowpack is a key element of water supply conditions. The index is based on snowpack, streamflow, precipitation and reservoir storage and is calculated uniquely for each water basin, which tends to limit interbasin and inter-regional index comparisons.
- [5] **Surface Water Supply Index (SWSI)** – Originally developed to complement the *Palmer Drought Severity Index (PDSI)*, the SWSI, unlike the PDSI which is basically a soil moisture index, was designed to be an indicator of surface water conditions in which mountain snowpack is a major component. The intent of the SWSI is to incorporate both hydrological and climatological features into a single index value resembling the PDSI. Four inputs are required for the SWSI: snowpack, streamflow, precipitation and reservoir storage. Because the SWSI calculations are unique to each watershed or defined region, it is difficult to compare SWSI values among these geographic areas.
- [6] **Reclamation Drought Index (RDI)** – The RDI was developed as a tool for defining drought severity and duration, and for predicting the onset and end of periods of drought. The impetus for the development of the RDI came from the *Reclamation States Drought Assistance Act of 1988*, which allowed states to seek federal drought relief assistance. The RDI is calculated at a river basin level and incorporates the supply components of precipitation, snowpack, streamflow and reservoir storage levels. The RDI differs from the *Surface Water Supply Index (SWSI)* in the incorporation of a temperature component. The RDI is adaptable to a particular region and readily accounts for both climate and water supply factors. RDI classifications include:

Reclamation Drought Index	Drought Condition
4.0 or more	Extremely wet
1.5 to 4.0	Moderately wet
0 to 1.5	Normal to mild wetness
0 to -1.5	Normal to mild drought
-1.5 to -4.0	Moderate drought
-4.0 or less	Extreme drought

- [7] **Deciles** – The deciles drought index system is based on a relative frequency distribution of long-term precipitation divided into tenths of the overall range of distribution. Each tenth division or precipitation category is termed a “decile” and ranges from the lowest (drought) ten percentile of precipitation levels to the highest (wet) ten percentile. By definition, the fifth decile is the median (middle-most) and is the precipitation amount not exceeded by 50 percent of the occurrences over the period of record. One disadvantage of the deciles drought index system is that a long climatological record is required for accurate deciles classifications. As a drought index, the deciles are

grouped into five classifications as follows:

Deciles Classifications	Drought Condition
Deciles 1-2 (lowest 20%)	Much below normal
Deciles 3-4 (next lowest 20%)	Below normal
Deciles 5-6 (middle 20%)	Near normal
Deciles 7-8 (next highest 20%)	Above normal
Deciles 9-10 (highest 20%)	Much above normal

Drought Period — The period of time over which *Drought Conditions* exist.

Drought Reserve Water — Generally, water reserved in upstream reservoirs for release for downstream purposes, e.g., municipal and industrial, agriculture, recreational, etc. Often provisions will be made such that drought reserve water will convert to *Fish Credit Water* if snowpack water content or runoff is deemed sufficient by a stipulated date.

Drought Year Supply — The average annual supply of a water development system during a defined *Drought Period*. For dedicated natural flow, it is the average flows or levels for specific drought water years for specific streams or bodies of water, or it is the *Environmental Flows* as required under specific agreements, water rights, court decisions, and congressional directives.

Drown — (1) To kill by submerging and suffocating in water or another liquid. (2) To drench thoroughly or cover with or as if with a liquid.

Drowned Stream — A term for a stream that has been flooded over from the sea. Also referred to as a *Flooded Stream*.

Droxtal — A small particle of ice that is formed by the direct freezing of supercooled water at a temperature below -30E Centigrade.

Drumlin — An elongated hill or ridge of *Glacial Drift*.

Dry — (1) Free from liquid or moisture. (2) Having or characterized by little or no rain, as a dry climate. (3) Marked by the absence of natural or normal moisture, as a dry month. (4) Not under water, as dry land. (5) Having all the water or liquid drained away, evaporated, or exhausted, as a dry river.

Dry Adiabatic Lapse Rate — The *Adiabatic Lapse Rate* for air not saturated with water vapor, or 0.98EC per 100 meters rise (5.4EF per 1,000 feet), expressed as:

$$\gamma_d = -dT/dz$$

where:

dT is the change in air temperature;

dz is the change in altitude; and

γ_d is the dry adiabatic lapse rate.

Compare to *Wet Adiabatic Lapse Rate*.

Dry Dam — A dam that has an outlet positioned so that essentially all stored water will be drained from the reservoir by gravity. The reservoir will normally be dry. Permanent storage is not involved, and the detention reservoir can be used for other purposes (farming, grazing, recreation) between flood periods.

Dry Deposition — The introduction of acidic material to the ground or to surface waters by the settling of particles containing sulfate or nitrate salts. Compare to *Wet Deposition*.

Dry Dock — (Nautical) A large dock in the form of a basin from which the water can be emptied or pumped, used for building or repairing a ship below its water line.

Dry Draw — A term used by some states to denote any ravine or watercourse not having an average daily flow of at least 0.4 cubic feet per second (twenty miner's inches) of water during the period May first to September thirtieth, inclusive.

Dry Farming — A type of farming practiced in arid areas without irrigation by planting drought-resistant crops and maintaining a fine surface tilth or mulch that protects the natural moisture of the soil from evaporation. Also referred to as *Dryland Farming*.

Dry Firn — See *Polar Firn*.

Dry Floodproofing — (1) Protecting a building by sealing its exterior walls to prevent the entry of flood waters. (2) A dry floodproofed building is sealed against floodwaters. All areas below the flood protection level are made watertight. Walls are coated with waterproofing compounds or plastic sheeting. Openings like doors windows, sewer lines and vents are closed, wether permanently, with removable shields, or with sandbags. The flood protection level should be no more than 2 or 3 feet above the top of the foundation because the buildings walls and floors cannot withstand the pressure of deeper water.

Dry Freeze — The freezing of ground without the formation of frost on exposed surfaces.

Dry Hydrants — A siphon buried beneath the water line that enables fire crews to draw, or "draft" water from ponds or other bodies of water located nearby. Such devices are used in more remote locations and are typically used only for interim purposes until a more consistent supply may be obtained to fight a fire.

Dry Ice — Solid carbon dioxide that sublimates at -78.5EC (-110EF) and is used primarily as a coolant.

Dry Mass — The mass of residue present after drying in an oven at 105 degrees Celsius for zooplankton and periphyton, until the mass remains unchanged. This mass represents the total organic matter, ash, and sediment in the sample. Dry mass is expressed in the same units as Ash Mass.

Dry Proofing — A flood-proofing method used to design and construct buildings so as to prevent the entrance of floodwaters.

Dry-Snow Avalanche — One of the basic categories of snow avalanche, composed of dry, powdery snow set in motion by the wind; it is the fastest-moving type of avalanche and is estimated to be able to reach speeds of over 250 miles per hour. Also referred to as *Drift Avalanche* and *Dust Avalanche*.

Dry Wash — A defined drainage channel in arid regions that is dry except following a major storm or heavy spring snowmelt.

Dry Weather Flow — Streamflow which results from precipitation that infiltrates into the soil and eventually moves through the soil to the stream channel. This is also referred to as *Baseflow*, or *Groundwater Flow*.

Dry Weight — The weight of animal or plant tissue after it has been dried in an oven at 65 degrees Celsius until a constant weight is achieved. Dry weight represents total organic and inorganic matter in the tissue, i.e., tissue with the weight of water removed.

Dry Well — A large infiltration trench for capturing relatively clean runoff. Not for infiltration of waste materials or other pollutants.

Drying Off — The process of reducing moisture to induce dormancy or a rest period in plants.

Dryland Farming — (1) Non-irrigated cropland. (2) The practice of crop production without irrigation in semiarid regions usually by using moisture-conserving farming techniques. Also referred to as *Dry Farming*.

Dual-Distribution Piping — A water distribution system that uses one set of pipes for the distribution of potable water and a separate set for the distribution of *Reclaimed Water*.

Dual Media Filtration — A system using two layers of dissimilar media, such as anthracite and sand.

Dual Rights — Refers to the recognition of typically two water appropriation systems. For example, the State of California operates under a dual system of *Riparian Water Rights* and *Appropriative Water Rights* pertaining to the allocation of its surface waters.

Ducking Stool — A seat attached to a plank and formerly used to plunge culprits tied to it into water.

Ducks Unlimited (DU) — For over six decades, Ducks Unlimited (DU) has maintained a singleness of purpose that has guided the organization to become one of the leading waterfowl and wetlands conservation entities in North America. The primary focus areas of DU's conservation efforts are in targeting for restoration and preservation regions of importance to waterfowl. This includes the most important nesting, migration, and wintering areas for migratory birds throughout North America. DU stands today as an internationally-recognized player in wetlands and wildlife conservation. DU's conservation programs have evolved and expanded over the years to address the habitat needs of waterfowl and other wildlife on ever changing landscapes. Today, DU and its many partners utilize the latest technology and up-to-date research to conserve habitat as efficiently and cost effectively as possible. DU's programs reach from the arctic tundra of Alaska to the tropical wetlands of Mexico. DU has assumed responsibility for restoring native grasslands in the Great Plains, restoring bottomland hardwood forests in the Lower Mississippi River Valley, protecting and enhancing the Chesapeake Bay watershed, and protecting and improving wetland habitats in the Central Valley of California and the Coastal Prairies of Texas, just to name a few. In this regard, DU believes that solutions to the fundamental problems faced by waterfowl must be anchored in the most current scientific understanding of waterfowl and the habitat resources upon which they rely. Research helps discover cause and effect relationships providing an understanding of these problems and also helps identify potential solutions. This information is critical to the success of DU's habitat conservation strategies. DU's Protection in Perpetuity Program accepts conservation easements in perpetuity through its affiliate Wetlands America Trust, as well as accompanying donations to cover associated costs such as the annual monitoring effort. DU agrees to monitor the property on a yearly basis to ensure the protection of its natural resources for years to come. Such protection will ensure that large acreages of wetlands, riparian habitats, and important uplands will be preserved for the benefits of waterfowl and other wildlife and the enjoyment of future generations.

Duckweed — Any of various small, free-floating, stemless aquatic flowering plants of the genus *Lemna*. Particularly useful in filtering *Constituents* and *Contaminants* out of water.

Duct — An often enclosed passage or channel for conveying a substance, especially a liquid or gas.

Duff — A general, non-specific term referring to the more or less firm organic layer on top of mineral soil, consisting of fallen vegetative matter in the process of decomposition, including everything from litter on the surface to pure humus.

Dugout — A man-made excavation below the ground surface that is used for storing water.

Duke University Wetland Center — The goal of the Duke University Wetland Center is to provide sound scientific knowledge that will lead to sustainable wetland functions and values for the nation and the world. The center works toward this goal by conducting, sponsoring, and coordinating research and teaching on critical wetland issues. The Duke Wetland Center is part of the Nicholas School of the Environment and Earth Sciences at Duke University. The Center's curriculum is designed to address the challenge facing society to determine how to manage our remaining wetland ecosystems, or construct new wetlands, to sustain ecological functions, maintaining hydrologic integrity and community structure, while allowing compatible development on adjacent landscapes. The Center's research is intended to:

- [1] Assess the impact of human values on ecological functions in wetlands;
- [2] Develop restoration or reconstruction wetland procedures that result in functional replacement of wetlands;
- [3] Devise best management practices for forestry and agriculture in or adjacent to wetlands to maintain water quality;
- [4] Address wetland ecosystem functions and values with respect to upland systems on the landscape;
- [5] Determine methods to evaluate wetland functions beyond their boundaries and far from adjacent landscapes; and
- [6] Evaluate wetlands in terms of scientific, economic and recreational factors.

Major wetland course work includes:

- [1] *Seminar on Key Wetland Ecology Issues* – Analysis of wetland functions, hydrology, biogeochemistry, decomposition, community habitat, and productivity;
- [2] *Wetland Ecology and Management* – The study of bogs, fens, marshes, and swamps with emphasis on the processes within the ecosystem, for example, biogeochemical cycling, decomposition, hydrology, and primary productivity;

- [3] **Wetland Field Skills** – A focus on the basics of wetland soils, hydrology, and vegetation needed for classification, assessment, and delineation; and
- [4] **Nutrient Biogeochemical Cycling in Estuaries** – Focuses on the biogeochemical cycling of nutrients (carbon, nitrogen, phosphorus, and sulfur) in estuarine environments, with a special focus on the abiotic and biotic processes that control the biogeochemical cycling of these nutrients.

Dumped Deposit — (Oceanography) An accumulation of sediment that is deposited faster than currents and waves can redistribute it.

Dune — A mound or ridge of sand piled up by wind.

Dune Pond (“Lake”) — A lake occupying a basin formed as a result of the blocking of the mouth of a stream by sand dunes migrating along the shore.

Dune Swale — A low place among sand dunes, typically moister and often having distinctive vegetation differing from the surrounding sand environment.

Dunk — To plunge into liquid; immerse as in to submerge oneself briefly in water. Synonymous with *Dip*.

Duplicates — (Water Quality) Two separate samples with separate containers taken at the same time at the same location.

Duralumin — An alloy of aluminum that contains copper, manganese, magnesium, iron, and silicon and is resistant to corrosion by acids and sea water. The term was originally a trademark.

Duration — The length of time the tide rises or falls, or the period of flow of a flood or ebb current.

Duration Curve — (1) A graph representing the percentage of time during which the value of a given parameter (e.g., water level, discharge, etc.) is equaled or exceeded. (2) A cumulative frequency curve that shows the percent of time during which specified units of items (e.g. discharge, head, power, etc.) were equaled or exceeded in a given period. It is the integral of the frequency diagram.

Duration of Ice Cover — The time from freeze-up to break-up of an ice cover.

Duripan — A subsurface (soil) horizon that is cemented by silica.

Duty (of Water) — (1) The total volume of water per year that may be diverted under a vested water right. (2) The total volume of irrigation water required for irrigation in order to mature a particular type of crop. In stating the duty, the crop, and usually the location of the land in question, as well as the type of soil, should be specified. It also includes consumptive use, evaporation and seepage from on-farm ditches and canals, and the water that is eventually returned to streams by percolation and surface runoff. Also see *Alpine Decree [Nevada]*, *Orr Ditch Decree [Nevada]*, *Bench Lands [Nevada]*, and *Bottom Lands [Nevada]* for additional information and examples of specific water duties. See *Water Duty*.

Dust Well — A small pit on the surface of a glacier or sea ice produced by the differential melting of the ice beneath a dark patch of dust or other particles.

Dusting — A light sprinkling as of snow.

Dynamic Equilibrium — (1) (General) An open system in a steady state in which there is continuous inflow of materials, but within which the form or character of the system remains unchanged. (2) (Surface Water) Within dynamic equilibrium the channel exhibits patterns of erosion and deposition but there is no net change in the input and output of materials. The state is stable but features may change over time. (3) (Groundwater) A condition of which the amount of recharge to an aquifer equals the amount of natural discharge.

Dynamic Head — (Irrigation) The total of the following factors: (1) the total static head, including suction lift; (2) friction head in the discharge pipeline; (3) head losses in fittings, elbows, and valves; and (4) pressure required to operate lateral lines.

Dynamic Ice — Pressure due to a moving ice cover or drifting ice. Pressure occurring at movement of first contact termed *Ice Impact Pressure*.

Dynamic Oceanography — (Oceanography) The study of ocean phenomena of force, such as waves, tides, and currents.

Dynamic Pressure — When a pump is operating, the vertical distance (in feet) from a reference point (such as a pump centerline) to the hydraulic grade line is the dynamic head.

Dynamic Roughness — (Oceanography) The degree of roughness at a given surface location, used in calculations of the wind's force. Also referred to as the *Roughness Length*.

Dysentery — A disorder of the gastrointestinal tract characterized by severe diarrhea with blood and pus in the feces. The disease frequently results from an infection by bacteria belonging to the genus *Shigella*.

Dystrophic — (Ecology) (1) Characterized by having brownish acidic waters, a high concentration of humic matter, and a small plant population. Typically used to describe a lake or pond. (2) Describing a body of fresh water that is deficient in calcium and low in plant nutrients, and that has a bottom covered with undecomposed plant fragments, for example, a *Dystrophic Lake*. Dystrophic waters are typically found in acid peat areas. (3) Describing plant and animal species that are characteristically found in such waters.

Dystrophic Lake — A lake characterized by a lack of nutrients, and often having a low pH (acidic) and a high humus content. Plant and animal life are typically sparse, and the water has a high oxygen demand. This stage follows the *Eutrophic Phase* in the life cycle of a lake.

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E. Coli (Escherichia Coli) — (1) A bacterial species which inhabits the intestinal tract of man and other warm-blooded animals. Although it poses no threat to human health, its presence in drinking water does indicate the presence of other, more dangerous bacteria. (2) *Escherichia coli* is a bacterium commonly found in the human intestine. For water quality analyses purposes, it is considered an *Indicator Organism*. These are considered evidence of water contamination. Indicator organisms may be accompanied by *Pathogens*, but do not necessarily cause disease themselves. Also see *Bacteria*.

Eagre — A high, often dangerous wave caused by the surge of a flood tide upstream in a narrowing *Estuary* or by colliding tidal currents. Also referred to as a *Bore*.

Early Seral Condition — Synonymous with poor ecological conditions.

Earth Island Institute (EII) — Based on a fundamental belief that life on earth is imperiled by human degradation of the Biosphere, the Earth Island Institute develops and supports projects that counteract threats to the biological and cultural diversity that sustains the environment. Through education and activism, these projects promote the conservation, preservation, and restoration of the Earth. The EII was founded in 1982 by veteran environmentalist David Brower (The Sierra Club and Friends of the Earth) and fosters the efforts of creative individuals by providing organizational support in developing projects for the conservation, preservation, and restoration of the global environment. EII provides activists the freedom to develop program ideas, supported by services to help them pursue those ideas, with a minimum of bureaucracy. Some of EII's accomplishments include:

- Launched more than 50 environmental projects including such notable alumnae as Rainforest Action Network, International Rivers Network, and Urban Habitat;
- Awarded six Project Censored awards for the Earth Island Journal, the first tree-free magazine in North America;
- Organized the largest and most successful consumer-led boycott resulting in the requirement that all tuna be dolphin-safe;
- Successfully incorporated social and environmental mandates in California's military base conversion process;
- Brought an end to commercial sea turtle exploitation in Mexico;
- Organized a highly influential series of Conferences on the Fate of Earth, bringing together leaders in the environmental, peace, and social justice communities to seek common strategies; and
- Brought major public and industry attention to the opportunities to replace paper from trees with agricultural alternatives like kenaf, consisting of wheat straw and corn.

Earth Island's Project Network consists of more than 30 projects worldwide. Through innovative education and activist campaigns, the EII is attempting to address many of the world's most pressing social and environmental issues. Some of these projects include:

- [1] Protecting rainforests, marine mammals, sea turtles, and indigenous lands;
- [2] Promoting organic and sustainable agriculture, ecological paper alternatives, and the emerging Russian environmental movement; and
- [3] Pursuing community-based habitat restoration, reduction of marine pollution, and development of urban multicultural environmental leadership.

Through education and activism, these issue-focused grassroots projects promote the conservation, preservation, and restoration of the Earth, and include:

- [1] **Aral Sea Environmental Alliance** – Promotes local and international initiatives to ensure the survival of the Aral Sea.
- [2] **Baikal Watch** – Promotes international activities for the permanent protection of biologically rich Lake Baikal and Siberia, as well as other related initiatives throughout Russia and northern Asia.
- [3] **Bay Area Wilderness Training (BAWT)** – Leads adult youth workers in developing skills to conduct safe, high quality wilderness trips for young people.
- [4] **Bluewater Network** – Protects public waters, lands and ecosystems while fighting damage caused by motorized recreation, oil and shipping industry practices and other marine polluters.
- [5] **Boreal Footprint Project** – Aims to reduce Americans' ecological footprint on the boreal forests of Canada and Alaska.
- [6] **Borneo Project** – Works with indigenous groups in Borneo to promote human rights, ecological justice, and self-determination through citizen diplomacy, mapping workshops, educational exchanges, and legal support.
- [7] **Brower Fund** – Provides advice, organizational support, internships, and small grants for short-term campaigns and projects and is an incubator for some of David Brower's most urgent initiatives.
- [8] **Campaign to Safeguard America's Waters (C-SAW)** – Developing the legal challenges and grassroots coalition to end the practice of federally sanctioned pollution dumping in mixing zones across the United States.
- [9] **Center for Safe Energy** – Supports the development and work of independent environmental non-profits in the

former Soviet Union which are concerned with energy issues including global warming, nuclear contamination, and safety.

- [10] **China Biodiversity Network** – Promotes local and international programs which will help ensure the protection of key species and key habitats in China and its northern border regions.
- [11] **Circle of Life Foundation** – Promotes efforts to protect and restore the Earth through education and outreach.
- [12] **City Talk** – Helps cities in the developing world find information, express their needs, communicate through the Internet with partner cities in the developed world, and hold discussions on sustainability.
- [13] **Climate Solutions** (formerly Atmosphere Alliance) – Works to effectively communicate the urgent need for action on global warming and promotes the rapid acceleration of clean energy technologies and more livable development of our communities.
- [14] **Earthinfo.org** – Provides information to promote and support environmentally responsible decision-making and local action by using the power and reach of the Internet.
- [15] **Estuary Action Challenge** – Collaborates with teachers to inspire environmental consciousness in children and cultivate a love of learning.
- [16] **Global Service Corps** – Provides opportunities for volunteers to learn about and work on village-based environmental and social justice projects in Kenya, Costa Rica, and Thailand.
- [17] **Grassroots Globalization Network (GGN)** – Promotes democratic ways for people to create healthier local economies, safer communities, and a cleaner environment.
- [18] **International Marine Mammal Project (IMMP)** – A major effort to stop the slaughter of dolphins, to end commercial whaling, and to end the use of drift nets worldwide.
- [19] **Japan Environmental Exchange** – Coordinates exchanges of citizen environmentalists between Japan and other countries to work on projects relating to environmental protection and restoration.
- [20] **John Muir Project** – An effort to end all timber sales on national forests and to redirect timber subsidies into worker retraining and ecological restoration.

Earthfill Dam — (1) A dam constructed primarily of earth. (2) A dam the main section of which is composed principally of earth, gravel, sand, silt, and clay. Also referred to as *Earth Dam*. Also see *Embankment Dam*.

Earthjustice — Earthjustice is a nonprofit law firm for the environment, representing – without charge – hundreds of public interest clients, large and small. Earthjustice works through the courts to safeguard public lands, national forests, parks, and wilderness areas; to reduce air and water pollution; to prevent toxic contamination; to preserve endangered species and wildlife habitat; and to achieve environmental justice. Founded in 1971 as *Sierra Club Legal Defense Fund*, Earthjustice has played a leading role in shaping the development of environmental law. From nine offices across the country Earthjustice attorneys routinely take on powerful special interests. Throughout its history, Earthjustice has achieved a number of landmark legal victories. When Congress tries to overturn these courtroom victories, Earthjustice's Policy and Legislation program in Washington D.C., works to halt legislative backlash and protect environmental laws such as the Clean Air Act (CWA), and the Endangered Species Act (ESA). Earthjustice's International Program addresses trade and the environment, human rights and the environment, and helps build environmental law in other countries. Earthjustice also runs environmental law clinics at Stanford University and the University of Denver, training students in public interest environmental law and increases its service to organizations throughout the country. The national office of Earthjustice is located in San Francisco, California (email: eajus@earthjustice.org). Regional offices are located in (1) Juneau, Alaska; (2) Oakland, California; (3) Denver, Colorado; (4) Tallahassee, Florida; (5) Honolulu, Hawaii; (6) New Orleans, Louisiana; (7) Bozeman, Montana; (8) Seattle, Washington; and (9) Washington, D.C.

Easement — A legal instrument enabling the giving, selling, or taking of certain land or water rights without transfer of title, such as for the passage of utility lines. An affirmative easement gives the owner of the easement the right to use the land for a stated purpose. A negative easement is an agreement with a private property owner to limit the development of his land in specific ways.

Ebb — (1) *Ebb Tide*. (2) To fall back from the *Flood Stage*.

Ebb Tide — That period of tide between a high water and the succeeding low water; falling tide. Also see *Tides*.

Echard — Soil water not available for absorption by plants.

Echo Sounder — A device for measuring the depth of water or the depth of an object below the surface by sending pressure waves down from the surface and recording the time until the echo returns from the bottom.

Ecohydraulics — A multi-disciplinary research focus among biologists and engineers aimed at improving sampling and modeling techniques, which integrates physical, chemical and ecological processes in aquatic ecosystems. The principal focus involves aquatic model development, verification and validation studies, multi-disciplinary assessment frameworks, river restoration and monitoring strategies, and applications of multi-disciplinary integrated assessment methodologies utilizing geographic information systems (GIS), remote sensing and decision support systems.

Ecological — (Ecology) (1) Of or relating to the environment or to the science of *Ecology*. (2) Relating to the prudent use or beneficial management of natural resources and the natural environment.

Ecological Approach — A method of natural resource planning and management that provides due consideration for the interrelationships between all species, including humans, and their environment.

Ecological Assessment — A process for describing the status of ecosystems, their components, related processes and effects, and associated interactions. An ecological assessment should address social, cultural, and political issues relevant to resource management and use scientifically supportable data.

Ecological Function Diversity — (Biodiversity Measure) Diversity (richness and evenness) of species associated with each of several ecological functions (e.g., nitrogen availability, plant pollination, nutrient cycling, sedimentation, soil aeration). This

measure provides an index of the diversity of processes.

Ecological Impact — The effect that a man-made or natural activity has on living organisms and their non-living (abiotic) environment.

Ecological Indicator — (1) An organism or group of organisms that reflect environmental conditions in a habitat (2) An individual species or a defined assemblage of organisms that serves as a gauge of the condition of the environment. The term is a collective term for response, exposure, habitat, and stressor indicators. For example, the bacterium *Escherichia coli* indicates the presence of sewage in water, and the mussel, *Mytilus edulis* lives in polluted waters. (3) Measurable features of an ecosystem that singularly or in combination with other features provide managerially useful evidence of water resource or ecosystem quality, or reliable evidence of trends in quality. Indicators can be biological, physical, or chemical measurements, and can sometimes have elements of more than one discipline, for instance, concentrations of chemicals in fish tissue. Also referred to as *Environmental Indicator*.

Ecological Integrity — The condition of the biotic (aquatic community) and abiotic components (water chemistry and habitat) of unimpaired waterbodies as measured by assemblage structure and function, water chemistry, and habitat measures.

Ecological Properties — Biotic and habitat attributes of a waterbody.

Ecological Restoration [SER] — Ecological restoration is the process of assisting the recovery and management of ecological integrity. *Ecological Integrity* includes a critical range of variability in *Biodiversity*, ecological processes and structures, regional and historical context, and sustainable cultural practices.

Ecological Risk Assessment — The application of a formal framework, analytical process, or model to estimate the effects of human actions on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose-response assessments, and risk characteristics.

Ecological Risk Assessment (CWA Section 403) [EPA] — As described by *U.S. Environmental Protection Agency (EPA)* in its Framework for Ecological Risk Assessment (1992), ecological risk assessment is the evaluation of the likelihood that adverse ecological effects might occur as a result of exposure to one or more environmental stressors. An environmental stressor is any physical, chemical, or biological factor that can cause an adverse environmental effect. Common environmental stressors include pollutants such as pesticides and organic chemicals, loss or alteration of habitat, and sudden or extreme changes in temperature. Ecological effects commonly evaluated include mortality and reproductive or developmental abnormalities in fish, marine mammals, and other marine organisms; the types and magnitude of those effects; and the likelihood of recovery. Ecological risk assessment also involves evaluating *Ecological Sustainability*. Ecological sustainability entails balancing ecological risks with socioeconomic factors to determine an acceptable level of health and quality of an ecological system. Section 403 of the *Clean Water Act (CWA)* provides for evaluation of the ecological risks and impacts associated with the discharge. Ten guidelines are listed under *Ocean Discharge Guidelines* (40 CFR Part 125, Subpart M [45 FR 65942, October 3, 1980]) and incorporate not only water quality impacts, but also impacts on the biological community and human health. The purpose of ecological risk assessment is to gain an improved understanding of the magnitude and likelihood of adverse environmental responses to human activities so we can make informed decisions based on the best scientific data and knowledge. Ecological risk assessment however, does not preclude human activity in the environment. Rather, when appropriately carried out, it should be used to identify situations where ecological sustainability is threatened.

Ecological Succession — An orderly, directional and therefore predictable process of development that involves changes in species structure and community processes over time. It results from a modification of the physical environment by the community and culminates in a stabilized ecosystem in which maximum biomass and symbiotic functions are maintained.

Ecological Sustainability [EPA] — Ecological sustainability entails balancing ecological risks with socioeconomic factors to determine an acceptable level of health and quality of an ecological system.

Ecology — The study of the relationships between all living organisms and the environment, especially the totality or pattern of interactions; a view that includes all plant and animal species and their unique contributions to a particular habitat.

Econometric Model Building — (Statistics) An iterative process for developing a model beginning with some information about the form and structure of the problem and with relevant data. The model building process typically follows a sequence of inter-related steps to include:

- [1] **Problem Identification and Data Selection** – Data is selected, compilation, screened, and analyzed, and the various series tested based on hypotheses of probable causation;
- [2] **Model Identification (or Specification)** – Selection of a general model structure is made based on the nature of the data and the types of outputs desired. Some of these include, for example, a simple single mathematical equation, or multiple (sequential) equations, statistically-based univariate (deterministic) autoregressive functions, multivariate analysis, simple ordinary least squares (OLS) regression, multiple regression, simultaneous equation, etc.;
- [3] **Estimation (Model Fitting)** – Based on the selection of a model structure, the data is used to best describe the behavior of the variable under observation, e.g., stream flows, reservoir levels, runoff, economic output, employment, consumer spending, etc.;
- [4] **Model Testing (and Refinement, as Necessary)** – The model's structure and variables chosen are then validated by applying the data and observing forecast errors with respect to known (sample) values;
- [5] **Forecasting** – Based upon the ability of the model to accurately "fit" or predict historical values, the model is used to forecast beyond the last data point as prescribed by scenarios under analysis.

Also see *Econometrics*, *Regression Analysis*, *Stochastic Process*, and *Deterministic Process*.

Econometrics — (Statistics) The application of statistical and mathematical methods to the analysis of economic data, with a purpose of giving empirical content to economic theories and verifying them or refuting them. Also see *Econometric Model Building*,

Regression Analysis, Stochastic Process, and Deterministic Process.

Ecoregion — (Ecology) (1) A continuous geographic area over which the macroclimate is sufficiently uniform to permit development of similar ecosystems on sites with similar geophysical properties. Ecoregions contain multiple landscapes with different spatial patterns of ecosystems. (2) A relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variable. See, for example, *World Wildlife Fund (WWF)*.

Ecospecies — A taxon consisting of one or more interbreeding *Ecotypes*.

Ecosphere — (Ecology) (1) The earth and the living organisms that inhabit it, along with all the environmental factors that operate on these organisms. (2) The mantle of earth and troposphere inhabited by living organisms; the “bio-bubble” that contains life on earth, in surface waters, and in the air. (3) The part of the atmosphere in which it is possible to breathe normally without aid, that portion of the troposphere from sea level to an altitude of 13,000 feet. Also see *Biosphere*.

Ecosystem — (Ecology) (1) A local biological community and its pattern of interaction with its environment. (2) Recognizable, relatively homogeneous units, including the organisms they contain, their environment, and all the interactions among them. (3) A community of animals, plants, and bacteria, and its interrelated physical and chemical environment. An ecosystem can be as small as a rotting log or a puddle of water, but current management efforts typically focus on larger landscape units, such as a mountain range, a river basin, or a watershed. (4) The interacting synergism of all living organisms in a particular environment; every plant, insect, aquatic animal, bird, or land species that forms a complex web of interdependency. An action taken at any level in the food chain, use of a pesticide for example, has a potential domino effect on every other occupant of that system. (5) A complex of interacting plants and animals with their physical surroundings. Ecosystems are isolated from each other by boundaries which confine and restrict the movement of energy and matter, for example, an ecosystem could be recognized at a watershed scale by designating an area of common drainage (i.e., topography determines movement of water). (6) An integrated system in nature, sufficient unto itself, to be studied as a separate entity. The system may be a rotting log in the forest, a coral atoll, a continent, or the entire earth with all its biota. Also referred to as *Ecological System* or *Holocoen*. Also see *Biodiversity*.

Ecosystem Functions — (1) The processes through which the constituent living and nonliving elements of ecosystems change and interact. The term *Ecological Function* is often used in reference to the role or specific contribution of an entity to system behavior. (2) Processes that are necessary for the self-maintenance of an *Ecosystem* such as primary production, nutrient cycling, decomposition, etc. The term is used primarily as a distinction from values.

Ecosystem Management — (1) A concept of natural resources management wherein human activities are considered within the context of economic, ecological, and social interactions within a defined area or region over both the short and long term. Its purpose is to meet human needs while maintaining the health, diversity, and productivity of ecosystems. (2) An approach to managing the nation’s lands and natural resources which recognizes that plant and animal communities are interdependent and interact with their physical environment (i.e., soil, water, and air) to form distinct ecological units called *Ecosystems*. The fact that these ecosystems span jurisdictional and political boundaries necessitates a more comprehensive and unified approach to managing them. Implementing the initial stage of a government-wide approach to ecosystem management typically requires clarifying the policy goals and undertaking certain practical steps to apply the principles being considered to include:

- [1] Delineating the ecosystem;
- [2] Understanding the system(s) ecologies;
- [3] Making management choices;
- [4] Unifying disparate data and information needs and sources; and
- [5] Adapting management on the basis of new information.

Ecosystem Management [BLM] — Ecosystem management by the U.S. Bureau of Land Management (BLM) recognizes that natural systems and processes must be sustained in order to meet the social and economic needs of future generations. Ecosystem management is the integration of ecological, economic, and social principles to manage biological and physical systems in a manner that safeguards the long-term ecological sustainability, natural diversity, and productivity of the landscape. The primary goal of ecosystem management is to conserve, restore, and maintain the ecological integrity, productivity, and biological diversity of public lands. Among other things, sustainable ecosystems provide habitat for fish and wildlife, clean drinking water for communities, wood fiber, forage, and recreational opportunities. Ecosystem management provides a framework in which scientific information will be used to more objectively evaluate resource trade-off decisions. Successful implementation of ecosystem management principles hinges on the integration of scientific information with resource management and allocation decisions.

Ecosystem Mapping — (Ecology) The art of constructing maps of the various plants that grow in a geographical area.

Ecosystem Principles [BLM] — According to the U.S. Bureau of Land Management (BLM), policy actions towards *Ecosystem Management* are to be governed by the following principles:

- [1] **Sustain the Productivity and Diversity of Ecological Systems** – Sustain ecological processes and functions in order to provide resilience to short-term stress and adaptation to long-term change; conserve, maintain, and restore the ecological integrity of the land and provide for human values, products, and services within the limits of ecological sustainability;
- [2] **Gather and Use the Best Available Scientific Information as the Cornerstone for Resource Allocations and Other Land Management Decisions** – Use scientific information (including biological, physical, economic, and social), research, new technologies, and the results of monitoring to determine appropriate local, landscape, and regional management strategies; develop closer working relationships between researchers and managers to better understand the effects of management activities on the land; work cooperatively with other federal and state agencies,

- researchers, local governments, and universities to prioritize restoration of degraded public lands; develop methodologies and technologies to restore impaired ecosystems;
- [3] **Involve the Public in the Planning Process and Coordinate with Other Federal, State, and Private Landowners** – Form partnerships and exchange data with federal, state, and private land managers, researchers, universities, Native American tribes, and interested public parties to resolve multi-jurisdictional resource issues, such as anadromous fish conservation and restoration, migratory bird habitat protection, and air and water quality; input from all interested and affected parties will be sought to develop management strategies that provide for social and economic well-being while safeguarding ecosystem health;
 - [4] **Determine Desired Future Ecosystem Conditions Based on Historic, Ecologic, Economic, and Social Considerations** – Coordinated across administrative and political boundaries to assist in determining the desired future condition of ecosystems; safeguard sustainable ecosystems, ecological, economic, political, and social factors will be considered to determine appropriate resource uses, cost of uses, products, and services on the public lands;
 - [5] **Work to Minimize and Repair Impacts to the Land** – Land-disturbing management activities on the public lands such as grazing, mining, timber harvest, right-of-way developments, and some recreation activities will be conducted in a manner that minimizes ecosystem fragmentation and degradation and maintains the ecological health and diversity of the land; management activities will include rehabilitation provisions that safeguard the long-term diversity and integrity of the land;
 - [6] **Adopt an Interdisciplinary Approach to Land Management** – Different programs that are currently separate will work together to set priorities and objectives to ensure consistency among different program areas, for example, range, wildlife and fisheries, forestry, recreation, and minerals disciplines will establish common objectives and management prescriptions for activities within critically important riparian areas; program advocacy will yield to the common objective of conserving and restoring sustainable ecosystems;
 - [7] **Base Planning and Management on Long-term Horizons and Goals** – Plan, manage, and monitor over the long term; sustaining ecosystems requires that sound, long-term ecological objectives are defined before short-term commercial and political objectives are identified; develop measurable and quantifiable resource condition objectives whenever possible; resource objectives will be met if: (a) site-specific and landscape conditions are at a desired condition, or (b) the health of the land is improving;
 - [8] **Reconnect Isolated Parts of the Landscape** – Management actions will focus on connecting all parts of the landscape, for example, rivers will be managed in association with floodplains, and management activities in upland habitats will be considered for their effects on riparian areas, surface waters, and groundwaters; and
 - [9] **Practice Adaptive Management** – Monitoring and inventory information will be used to assess the effect of management actions on ecosystem health; results will be integrated into management decisions and management will be adapted as resource conditions warrant; management prescriptions will adapt to changing ecosystem conditions with consideration given to the management actions of other federal, state, and private landowners; monitoring programs will clearly describe baseline resource threshold levels, which, if exceeded, will trigger delay, modification, or cancellation of management activities and/or refinement of management direction; whenever possible, management, monitoring, and inventory will be coordinated across administrative boundaries and conducted in a manner that effectively describes the health of an ecosystem; monitoring will ensure that: (a) management direction is implemented; (b) management direction is effective; and (c) management assumptions about ecological conditions and their response to treatments remain valid over time.

Ecosystem Restoration — Actions taken to modify an ecosystem for the purpose of re-establishing and maintaining desired ecological structures and processes.

Ecosystem Stress — The nation's and world's *Ecosystems* are either threatened or suffering from natural and human-induced *Stressors*. These include *Harmful Algal Blooms (HABs)*, toxic contaminants, coastal *Eutrophication*, nonindigenous species, land cover and land use change, and habitat degradation. These stressors often act synergistically (mutually supportive) and antagonistically (in opposition), and as a result their cumulative impacts on ecosystem structure and function are not well understood and frequently difficult to assess and manage.

Ecosystem Structure — (1) The physical elements and spatial arrangement of the living and nonliving elements within an *Ecosystem*. (2) Attributes related to instantaneous physical state of an ecosystem; examples include species population density, species richness or evenness, and standing crop *Biomass*.

Ecosystem Sustainability — The capacity of an *Ecosystem* for long-term maintenance of ecological processes and functions, biological diversity, and productivity. Also called *Ecological Sustainability*.

Ecotone — (1) A habitat created by the juxtaposition of distinctly different habitats; an edge habitat; or an ecological zone or boundary where two or more ecosystems meet. (2) A transition line or strip of vegetation between two communities, having characteristics of both kinds of neighboring vegetation as well as characteristics of its own.

Ecotype — (1) A locally adopted population of a species which has a distinctive limit of tolerance to environmental factors. (2) A subspecies that is especially adapted to a particular set of environmental conditions.

Edaphic — (Ecology) (1) Pertaining to the chemical and physical characteristics of the soil, without reference to climate. (2) Soil characteristics, such as water content, pH, texture, and nutrient availability, that influence the type and quantity of vegetation in an area.

Edaphon — The aggregate of organisms that live in the soil.

Eddy — (1) A current, as of water or air, moving contrary to the direction of the main current, especially in a circular motion. (2) A place where the current either stops or turns to head upstream. Usually found below obstructions and on the inside of bends.

Eddy Current — A circular water movement that develops when the main flow becomes separated from the bank. The eddy current may then be set up between the main flow and the bank.

Eddy Cushion — The layer of slack or billowing water that pads the upstream face of rocks and other obstructions. See *Pillow*.

Eddy Fence — The sharp boundary at the edge of an eddy between two currents of different velocity or direction. Usually marked by swirling water and bubbles. Also called an *Eddy Line* and an *Eddy Wall*.

Edema, also Oedema — (Botany) Extended swelling in plant organs caused primarily by an excessive accumulation of water.

Edge Water (or Edgewater) — The water that surrounds, borders on, or lies under a gas pool or oil-bearing formation.

Eductor — A hydraulic device used to create a negative pressure (suction) by forcing a liquid through a restriction, such as a Venturi. An eductor or aspirator (the hydraulic device) may be used in the laboratory in place of a vacuum pump. As an injector, it is used to produce vacuum for chlorinators.

Edwards Decree [Nevada] — The Edwards Decree was issued on October 8, 1935 and represented a modification of adjudicated water rights for the Humboldt River based on the October 20, 1931 *Bartlett Decree*. Due to subsequent protests to the issuance of the Bartlett Decree, on December 16, 1931, the first of a number of rulings for the modification, correction and amendment of the Bartlett Decree was made by Judge H.W. Edwards. This was followed by additional changes and amendments entered on April 27, 1933, February 8, 1934, June 8, 1934, October 1, 1934, November 19, 1934, February 11, 1935, and finally on March 11, 1935. Collectively, this compilation of modifications and changes to the 1931 Bartlett Decree became known as the Edwards Decree. One particular change of some importance removed the Bartlett Decree's language pertaining to the formal division of the Humboldt River system into a District No. 1 below Palisade and a District No. 2 above Palisade. In its place, the Edwards Decree merely established specific irrigation seasons and reaffirmed the three classes of land for specific water rights, the water duty for each land class, and the period over which water was to be received by these lands. As most of the corrected water-rights contained within the Edwards Decree applied to lands above Palisade (i.e., the upper Humboldt River Basin), the Edwards Decree was applied to and used for distribution of the Humboldt River system's waters above Palisade, while the Bartlett Decree continued to apply to and be used in the distribution of water below Palisade. In general, the Edwards Decree provided for a flow of 1.23 cfs per 100 acres of decreed land or at proportional rates. Three land classes were established (the same as for the Bartlett Decree) with different dates of use and number of days of allowed irrigation. Each sub-basin within the overall Humboldt River Basin had its unique amount of decreed land and decreed water within the three land classes (A, B and C). Diverted water for irrigation purposes was to be measured where the main ditch enters or becomes adjacent to the land to be irrigated. With respect to adjudication of the Humboldt River, also see *Carville Decree*.

Effective Corrosion Inhibitor Residual — A concentration of corrosion inhibitor sufficient to form a protective coating on the interior walls of a pipe, reducing its corrosion potential.

Effective Height — The difference in elevation in feet between the lowest point in the cross section taken along the centerline of the dam and crest of the emergency spillway. If there is no emergency spillway, the top of the dam is the upper limit.

Effective Porosity — The amount of interconnected pore space through which fluids can pass, expressed as a percentage of the total volume occupied by the interconnecting interstices. Porosity may be primary, formed during deposition or cementation of the material, or secondary, formed after deposition or cementation, such as fractures. Part of the total porosity will be occupied by static fluid being held to the mineral surface by surface tension, so effective porosity will be less than total porosity.

Effective Precipitation (or Rainfall) — (1) The portion of precipitation that becomes runoff. (2) In irrigation, the portion of precipitation that is available in the soil for consumptive use. (3) That portion of precipitation which remains on the foliage or in the soil that is available for *Evapotranspiration*, and reduces the withdrawal of soil water by a like amount. As described by the U.S. Bureau of Reclamation, that part of the precipitation falling on an irrigated area that is effective in meeting the *Crop Consumptive Use* requirements.

Effective Size (E.S.) — (1) The 90-percent-retained size of a sediment as determined from a grain-size analysis; therefore, 10 percent of the sediment is finer and 90 percent is coarser. (2) The diameter of the particles in a granular sample (filter media) for which 10 percent of the total grains are smaller and 90 percent larger on a weight basis. Effective size is obtained by passing granular material through sieves with varying dimensions of mesh and weighing the material retained by each sieve. The effective size is also approximately the average size of the grains.

Effective Snowmelt — The portion of snowmelt that becomes runoff.

Effective Soil Depth — (Water Treatment) The depth of soil in the leach field trench that provides a satisfactory percolation area for the septic tank effluent.

Effective Velocity — The actual velocity of *Groundwater* as it percolates through a water-bearing substance, equal to the volume of water passing through a unit cross-sectional area divided by the *Effective Porosity*.

Efficiency (Irrigation) — (1) A measure of a distribution system's ability to transport and apply water to a desired effect with a minimum of effort, expense, or waste. (2) With reference to an irrigation water delivery system, the proportion of the amount of water delivered for irrigation use compared to the total amount of water released to meet that delivery (i.e., the amount of delivery divided by the amount of release). With respect to irrigation project efficiency, the following terms generally apply:

- [1] **Canal Efficiency** — The volume of water diverted into a canal system versus total water available for farm headgate deliveries;
- [2] **Irrigation Efficiency** — The percentage of water applied that can be accounted for in soil moisture increase; and
- [3] **Farm Efficiency** — The amount of water actually required for growing a crop compared to the amount of irrigation water that is diverted at the farm headgate.

Efficient Water Management Practices (EWMP)—Agricultural Water Use — The agricultural water use equivalent of *Best Management Practices (BMP)* as applied to urban water use, efficient water management practices cover the spectrum of methods to improve both the efficiency and conservation of agricultural water use by (1) enhancing irrigation management services,

measurement, and accounting; (2) improving the physical system of irrigation delivery, distribution, and drainage; and (3) promoting the modification of and adjustments to the institutional system of water use by agricultural interests to include information and educational programs. More specifically, the most significant of these efficient water management practices would include:

Irrigation Management

- Improve water measurement and accounting;
- Conduct irrigation efficiency studies;
- Provide farmers with “normal year” and “real time” irrigation, scheduling, and crop evapotranspiration ET information;
- Monitor surface water qualities and quantities;
- Monitor soil moisture;
- Promote efficient pre-irrigation techniques;
- Monitor soil salinity and build-up;
- Provide on-farm irrigation system evaluations;
- Monitor quantity and quality of drainage waters;
- Evaluate and improve water user pump efficiencies;
- Designate a water conservation coordinator.

Physical Improvement

- Improve the condition and type of flow measuring devices;
- Automate canal structures;
- Line or pipe ditches and canals;
- Modify distribution facilities to increase the flexibility of water deliveries;
- Construct or line regulatory reservoirs;
- Construct Irrigation District tailwater reuse systems;
- Develop recharge basins for systems;
- Improve on-farm irrigation and drainage systems;
- Evaluate efficiencies of Irrigation District pumps;
- Provide education seminars.

Institutional Adjustments

- Improve communication and cooperative work among district, farmers, and other agencies;
- Change the water fee structure in order to provide incentives for more efficient use of water and drainage reduction;
- Increase flexibility in water ordering and delivery;
- Conduct public information programs;
- Facilitate financing capital improvements for Irrigation Districts and on-farm irrigation systems;
- Increase conjunctive use of groundwater and surface water;
- Facilitate, where appropriate, alternative land uses.

Effloresce — (Chemistry) To become a powder by losing water of crystallization, as when a hydrated crystal is exposed to air.

Efflorescence — (1) (Chemistry) The deposit that results from the process of *Efflorescing*, called bloom. (2) A growth of salt crystals on a surface caused by evaporation of salt-laden water.

Effluent — (1) Flowing out or flowing away; something that flows out or forth, especially a stream flowing out of a body of water. (2) A stream that flows out of a larger stream, a lake, or another body of water. (Water Quality) (3) A waste liquid discharge from a manufacturing or treatment process, in its natural state or partially or completely treated, that discharges into the environment. The outflows, usually offensive, from sewage or industrial plants, etc. (4) Wastewater discharged from a point source, such as a pipe. The discharge from a relatively self-contained passage, such as from a sewage treatment plant or an industrial smokestack, or a nuclear power plant thermal discharge, generally carrying pollutants. (5) Water or some other liquid – raw, partially or completely treated – flowing from a reservoir, basin, treatment process or treatment plant. (6) Discharged wastewater such as the treated wastes from municipal sewage plants, brine wastewater from desalting operations, and coolant waters from a nuclear power plant.

Effluent Flow — The flow of water from the ground into a body of surface water.

Effluent Guidelines [EPA] — Technical documents developed by the *U.S. Environmental Protection Agency (EPA)* which set discharge limits for particular types of industries and specific pollutants.

Effluent Limitations [EPA] — (Water Quality) (1) Limits on the amounts of pollutants set by the *U.S. Environmental Protection Agency (EPA)* which may be discharged by a facility; these limits are calculated so that water quality standards will not be violated even at low stream flows. (2) An amount or concentration of a water pollutant that can be legally discharged into a water body by a *Point Source (PS)*, expressed as the maximum daily discharge, the maximum discharge per amount of product, and/or the concentration limit in the wastewater stream, as a 24-hour or 30-day average. The applicable technology-based standard is set by the EPA by *Standard Industrial Classification (SIC) Code*, but differs between new and existing sources and by broad types of water pollutants: conventional pollutants, toxic pollutants, non-conventional, nontoxic pollutants; dredge and fill wastes; and heat discharges.

Effluent Limits — (Wastewater Treatment) Pollutant limitations developed by a *Publicly-Owned Treatment Works (POTW)* for industrial plants discharging to the POTW system. At a minimum, all industrial facilities are required to comply with federal

prohibited discharge standards. The industries covered by federal categorical standards must also comply with the appropriate discharge limitations. The POTW may also establish local limits more stringent than or in addition to the federal standards for some or all of its industrial users.

Effluent Seepage — (1) Diffuse discharge of *Groundwater* to the ground surface. (2) The movement of water from the land surface into the ground.

Effluent Standard — The maximum amounts of specific pollutants allowable in wastewater discharged by an industrial facility or wastewater treatment plant. The standards are set for individual pollutants and apply across all industrial categories. This term can be contrasted with *Effluent Limitations*, which are set for individual pollutants by *Standard Industrial Classification (SIC) Code*.

Effluent Stream — (1) A surface stream that flows out of a lake or any branch of a larger stream. (2) A stream that intersects and receives its water from the water table. Also referred to as *Gaining Stream*. Also see *Stream*.

Effluent Trading [EPA] — Effluent trading is a program sanctioned by the *U.S. Environmental Protection Agency (EPA)*, to attain and/or maintain water quality standards by allowing sources of pollution to achieve pollutant reductions through substituting a cost-effective and enforceable mix of controls on other sources of discharge. To take advantage of effluent trading, a point source must be in compliance, and remain in compliance, with applicable technology-based limits. Intra-plant trades must also have a technology-based floor, while the technology floor for pretreatment trading is determined by the categorical standards. The EPA expects that most trades will be covered by *Total Maximum Daily Loads (TMDL)* or similar watershed-based analysis. EPA encourages the program on a *Watershed Protection Approach* basis and believes that effluent trading is an innovative way for community stakeholders (e.g., regulated sources, non-regulated sources, regulatory agencies and the public) to develop more “common sense” solutions to water quality problems in their watersheds. Effluent trading potentially offers a number of economic, environmental, and social benefits. Feasible effluent trading techniques include:

- [1] **Intra-Plant Trading** – A point source is allocated pollutant discharges among its outfalls in a cost-effective manner, provided that the combined permitted discharge with trading is no greater than the combined permitted discharge without trading in the watershed;
- [2] **Pretreatment Trading** – An indirect industrial point source(s) that discharges to a publicly owned treatment works arranges, through the local control authority, for additional control by other indirect point sources beyond the minimum requirements in lieu of upgrading its own treatment for an equivalent level of reduction;
- [3] **Point/Point Source Trading** – A point source(s) arranges for other point source(s) in a watershed to undertake greater than required control in lieu of upgrading its own treatment beyond the minimum technology-based treatment requirements in order to more cost-effectively achieve water quality standards;
- [4] **Point/Nonpoint Source Trading** – A point source(s) arranges for control of nonpoint source discharge(s) in a watershed in lieu of upgrading its own treatment beyond the minimum technology-based treatment requirements in order to more cost-effectively achieve water quality standards; and
- [5] **Nonpoint/Nonpoint Source Trading** – A nonpoint source(s) arranges for more cost-effective control of other nonpoint sources in a watershed in lieu of installing or upgrading its own control.

Effluent trading requires a complete understanding of all pollution sources affecting a watershed, and a watershed management plan is the most logical means for generating this type of information. In that regard, also see *Comprehensive State Ground Water Protection Program (CSGWPP) [EPA]*.

Effluvium — An invisible exhalation or vapor, especially one that is disagreeable or noxious.

Ejector — (1) A device using a jet of water to withdraw a fluid from a space. (2) A device used to disperse a chemical solution into water being treated.

Ekman Convergence — (Oceanography) A zone of convergence between warm and cold water masses, caused by the *Ekman Transport* of surface water.

Ekman Dredge — A dredge that has opposable jaws operated by a messenger traveling down a cable to release a spring catch and that is used in ecology for sampling the bottom of a body of water.

Ekman Transport — (Oceanography) the net mass displacement of water from one place to another, caused by wind blowing steadily over the surface; the net mass transport is 90° to the right (in the Northern Hemisphere) of the wind's direction.

El Niño — (Oceanography and Meteorology) (1) A complex set of changes in the water temperature in the Eastern Pacific equatorial region, producing a warm current; it occurs annually to some degree between October and February, but in some years intensifies and causes unusual storms and destruction of marine life. (Derived from Spanish for “the child,” meaning the Christ child as it typically begins at Christmas time.) (2) The name of a southward-flowing ocean current off the coast of Peru causing an irregularly occurring flow of unusually warm surface water along the western coast of South America that is accompanied by abnormally high rainfall in usually arid areas and that prevents upwelling of nutrient-rich cold deep water causing a decline in the regional fish population. It typically results in a warm inshore current flowing along the coast of Ecuador and about every seven to ten years it extends southward down the coast of Peru with frequently devastating effects on weather, crops, and fishing (due to adverse effects on plankton). El Niño's warm and nutrient-poor waters cause great damage to the fishing industry and also to the birds feeding there, which are an important source of guano. The climatic effects of large-scale El Niño disturbances also cause flooding and drought conditions over a wide area, sometimes extending as far as the southern Pacific Ocean, Europe, Africa, and Asia. Such disturbances have taken place in 1953, 1957-58, 1972-73, 1976, 1982-83, and 1992. It is also believed that this condition (*El Niño Effect*) has more far-reaching effects on climatological patterns in the Western Hemisphere and also influences storm patterns in the western Atlantic Ocean region (Caribbean and Gulf of Mexico). It has generally been found that the presence of El Niño tends to reduce hurricane activity while the presence of *La Niña*, or cool eastern Pacific waters, tends to increase hurricane activity. Also see *Hurricane Forecasting*.

El Niño/Southern Oscillation (ENSO) — (Oceanography and Meteorology) The expansion of warm waters in the Pacific Warm Pool east across the International Date Line, sometimes all the way to the coast of Peru, at which time it is called an *El Niño* event. The Pacific Warm Pool, located north and east of New Guinea, is approximately the size of the United States and gets its name from the fact that surface temperatures never go below 86°F (30°C). When this body of water expands, as it did in the early 1980s, the consequences of a warming trend on the coast of South America are dire. Typically, the fishing industry collapses in Peru as the plankton die off and fish head for cooler waters and torrential rainfalls bring devastating floods.

Electric Power Water (Public Utility) — Water withdrawn by public utilities for hydroelectric power generation and condenser cooling.

Electrical Conductance — A measure of the ease with which a conducting current can be caused to flow through a material under the influence of an applied electric field. It is the reciprocal of resistivity and is measured in mhos per foot (meter). Used to measure the amount of constituents in a sample of water.

Electrical Conductivity — A measure of the salt content of water.

Electrical Log — A record of electrical-resistivity tests made at various depths in a well.

Electrical Resistivity — The property of a material which resists the flow of electrical current measured per unit length through a unit cross-sectional area.

Electrochemical Reaction — Chemical changes produced by electricity (electrolysis) or the production of electricity by chemical changes (galvanic action). In corrosion, a chemical reaction is accompanied by the flow of electrons through a metallic path. The electron flow may come from an external force and cause the reaction, such as electrolysis caused by a D.C. (direct current) electric railway or the electron flow may be caused by a chemical reaction as in the galvanic action of a flashlight dry cell.

Electrochemical Series — A list of metals with the standard electrode potentials given in volts. The size and shape of the electrode potential indicates how easily these elements will take on or give up electrons, or corrode. Hydrogen is conventionally assigned a value of zero.

Electrodialysis — (1) The process of transferring ions through selective membranes by means of an applied direct current so that ions of like electrical charge move in one direction through one membrane and ions with the opposite charge move in the other direction through another membrane. (2) A treatment process that uses electrical current and an arrangement of permeable membranes to separate soluble minerals from water. Often used to desalinate salt or brackish water. In the electrodialysis process, salts are extracted from the feedwater by using a membrane with an electrical current to separate the ions. The positive ions go through one membrane, while the negative ions flow through a different membrane, leaving the end product of freshwater. Also see *Reverse Osmosis*.

Electrodialysis Reversal (EDR) — A treatment process in which minerals and other constituents in water are separated by an electrical charge. The resulting ions are transferred through membranes from a less concentrated to a more concentrated solution. By varying the amount of the electrical charge input to the system, it is possible to remove the dissolved solids in water to the extent desired. The EDR process can also be used in desalinating sea water.

Electrolysis — The passage of an electric current through an *Electrolyte*, causing the migration of the positively charged ions to the negative electrode (cathode) and the negatively charged ions to the positive electrode (anode).

Electrolyte — (1) (Chemistry) A substance which dissociates (separates) into two or more ions when it is dissolved in water. Any compound that dissociates into ions when dissolved in water. The solution that results will conduct an electric current. For example, table salt (NaCl) is an electrolyte. (2) (Physiology) Any of various ions, such as sodium, potassium, or chloride, required by cells to regulate the electric charge and flow of water molecules across the cell membrane.

Electromotive Series — A list of metals and alloys presented in the order of their tendency to corrode (or go into solution). Also called the *Galvanic Series*. This is a practical application of the theoretical *Electrochemical Series*.

Electron — An extremely small, negatively charged particle; the part of an atom that determines its chemical properties.

Electrophoresis — The migration of charged colloidal particles (*Colloids*) or *Molecules* through a solution under the influence of an applied electric field usually provided by immersed electrodes. Also call *Cataphoresis*.

Element — (1) (Chemistry) Any substance that cannot be separated into different substances by ordinary chemical methods. A substance which cannot be separated into its constituent parts and still retain its chemical identity. For example, sodium (Na) is an element. (2) (Historical) Any of four substances (earth, air, fire, and water) formerly regarded as a fundamental constituent of the universe. (3) (Meteorology) Weather conditions, especially violent or severe weather.

Elevated Ditch — Earth-filled, constructed to specifications similar to those for earthfill dams, to provide normal grade as a substitute for flumes or siphons. Also referred to as *Raised Ditches*.

Elevation — (1) The variation in the height of the earth's surface as measured by the vertical distance from a known datum plane, typically *Mean Sea Level (MSL)*. (2) In retrofitting, the process of raising a house or other building so that it is above the height of a given flood.

Elevation Datum Plane — Arbitrary surface that serves as a common reference for the elevations of points above or below it. Elevations are expressed in terms of feet, meters, or other units of measure and are identified as negative or positive depending on whether they are above or below the datum plane.

Elevation Head — The potential energy in a hydraulic system, represented by the vertical distance between the hydraulic system (pipe, channel, etc.) and a reference level, and expressed in length units. The sum of the elevation head and the *Pressure Head* is equal to the *Hydraulic Head*. Also referred to as the *Total Head*.

Eligible Costs — The construction costs for waste-water treatment plants upon which U.S. Environmental Protection Agency (EPA) grants are based.

Eligible Land — An irrigation project land which has a valid right and which is classified as irrigable or has a paid-out water right.

Elimination — The act, process, or an instance of eliminating or discharging, as the removal from a molecule of the constituents

of a simpler molecule for example, ethylene is formed by the elimination of water from ethanol.

Elutriate — To purify, separate, or remove by washing, decanting, and settling.

Elutriation — (Wastewater Treatment) (1) Separation of solid waste into heavy and light fractions by washing. (2) The washing of digested sludge with either fresh water, plant effluent or other wastewater. The objective is to remove (wash out) fine particulates and/or the alkalinity in sludge. This process reduces the demand for conditioning chemicals and improves settling or filtering characteristics of the solids.

Eluviation — (1) The removal of soil material in suspension (or in solution) from a layer or layers of a soil. (2) The transportation of dissolved or suspended material within the soil by the movement of water when rainfall exceeds evaporation.

Eluvium — (Geology) (1) Fine soil material that has been moved and deposited by the wind. (2) An accumulation of residual rock debris formed in place by weathering and disintegration. (3) (Ecology) A sand dune community.

Embacle — (1) A pile of ice formed in a stream after a re-freeze. (2) The process whereby such a pile is formed.

Embankment — An artificial deposit of material that is raised above the natural surface of the land and used to contain, divert, or store water, support roads or railways, or for other similar purposes.

Embankment Dam — A dam structure constructed of fill material, usually earth or rock, placed with sloping sides and usually with a length greater than its height. Types of embankment dams include:

- [1] **Earthfill or Earth Dam** — An embankment dam in which more than 50 percent of the total volume is formed of compacted fine-grained material obtained from a borrow area (i.e., excavation pit);
- [2] **Fill Dam** — Any dam constructed of excavated natural materials or of industrial waste materials;
- [3] **Homogeneous Earthfill Dam** — An embankment dam constructed of similar earth material throughout, except for the possible inclusion of internal drains or drainage blankets; distinguished from a *Zoned Earthfill Dam*;
- [4] **Hydraulic Fill Dam** — An embankment dam constructed of materials, often dredged, that are conveyed and placed by suspension in flowing water;
- [5] **Rockfill Dam** — An embankment dam in which more than 50 percent of the total volume is comprised of compacted or dumped pervious natural or crushed rock;
- [6] **Rolled Fill Dam** — An embankment dam of earth or rock in which the material is placed in layers and compacted by using rollers or rolling equipment; and
- [7] **Zoned Embankment Dam** — An embankment dam which is composed of zones of selected materials having different degrees of porosity, permeability, and density.

Emerged Bog — (Ecology) A *Bog* that grows above the water table by drawing water up through the vegetation.

Emergence — (1) The point at which an underground stream emerges to become a surface stream. (2) (Geology) The exposure of a land mass formerly under water, resulting from an uplift of land or a lowering of water level.

Emergency Action Plan (Dam) — A predetermined plan of action to be taken to reduce the potential for property damage and loss of lives in a downstream area affected by a dam break or excessive spillway discharges.

Emergency and Hazardous Chemical Inventory [NEPA/EPA] — An annual report required by *National Environmental Policy Act (NEPA)* and the *U.S. Environmental Protection Agency (EPA)* and made by facilities having one or more extremely hazardous substances or hazardous chemicals above certain weight limits, as specified in Section 311 and 312 of *Emergency Planning and Community Right-to-Know Act (EPCRA)*.

Emergency Planning and Community Right-to-Know Act (EPCRA) [NEPA/EPA] — Also known as *Superfund Amendments and Reauthorization Act (SARA)* Title III, this act provides an infrastructure at the state and local levels to plan for chemical emergencies. Facilities that store, use, or release certain chemicals, may be subject to various reporting requirements to the *U.S. Environmental Protection Agency (EPA)* under EPCRA. Reported information is then made publicly available so that interested parties may become informed about potentially dangerous chemicals in their community.

Emergency Preparedness Coordinator [NEPA/EPA] — The local government official designated to be notified immediately of chemical emergencies (e.g., spills, chemical releases, explosions, or fires) under *Emergency Planning and Community Right-to-Know Act (EPCRA)*.

Emergency Preparedness Plan (EPP) — (Dam Safety) A predetermined plan of action to be taken to reduce the potential for property damage and loss of lives in an area that may be affected by a dam break.

Emergency Program [FEMA] — The phase of the *National Flood Insurance Program (NFIP)* which a community enters prior to the completion of an individual community flood insurance study. It is intended to provide a first layer amount of insurance at federally-subsidized rates on all existing structures and new construction begun prior to the effective date of a *Flood Insurance Rate Map (FIRM)*, in return for the community's adoption of general floodplain management regulations.

Emergency Spillway — A dam spillway built to carry runoff in excess of that carried by the principal spillway; a secondary spillway designed to operate only during exceptionally large floods. Also referred to as *Auxiliary Spillway*. Also see *Spillway*.

Emergent — Rising above a surrounding medium, especially a fluid. Having part of a plant aerial and the rest submersed; with parts extending out of the water.

Emergent Hydrophytes — Erect, rooted, herbaceous *Angiosperms* that may be temporarily to permanently flooded at the base but do not tolerate prolonged inundation of the entire stem or plant. Familiar examples are cattails, bulrushes, and saltmarsh cordgrass.

Emergent Mosses — Mosses occurring in wetlands, but generally not covered by water.

Emergent Plant — A plant that grows in shallow water with the root system submerged under the water and the upper vegetation rising above the water surface. Also see *Emergent Hydrophytes*.

Emergent Wetland — Typically, a wetland classification characterized by erect, rooted, herbaceous, hydrophytes, excluding mosses

and lichens, and which is present for most of the growing season.

Emersed — (Botany) Rising above the surface of water as emersed aquatic plants.

Emersion Zone — (Ecology) The part of a lakeshore or seashore that is submerged only at extreme high tide or high water.

Eminent Domain — (Legal) (1) The right of a government to appropriate private property for public use, usually with fair compensation to the owner. (2) The authority of the federal or state government, or an agency or party authorized by the federal government, to condemn all interest in land for public purposes, after payment of just compensation.

Empedocles — Fifth century B.C. Greek philosopher who believed that all matter is composed of elemental particles of fire, water, earth, and air and that all change is caused by motion.

Empirical — (Statistics) Based on experience or observations, as opposed to theory or conjecture.

Emulsion — A suspension of small *Globules* of one liquid in a second liquid with which the first will not mix.

Encroachment — (1) Any physical object placed in the floodplain that hinders the passage of water or otherwise affects flood flows, such as fill, excavation, storage of equipment and materials, or buildings. (2) The advance or infringement of uses, plant growth, fill, excavation, buildings, permanent structures or development into a floodplain which may impede or alter the flow capacity of a floodplain.

End Moraine — (Geology) A ridge-like mass of glacial debris that accumulates at the front, lower, or outer end of an actively flowing glacier. Also referred to as *Frontal Moraine*.

End Point — Samples are titrated to the end point. This means that a chemical is added, drop by drop, to a sample until a certain color change (blue to clear, for example) occurs. This is called the “end point” of the titration. In addition to a color change, an end point may be reached by the formation of a precipitate or the reaching of a specified pH. An end point may be detected by the use of an electronic device such as a pH meter.

Endamoeba Histolytica — A waterborne disease organism causing amoebic dysentery.

Endangered Species — (Ecology) (1) A species of animal or plant that has been identified as in danger of becoming extinct because of harmful human activity or environmental factors, and therefore is the object of protective regulations and conservation measures. (2) Any plant or animal species threatened with extinction by man-made or natural changes throughout all or a significant area of its range; identified by the Secretary of the Interior as “endangered”, in accordance with the 1973 *Endangered Species Act (ESA)*, below.

Endangered Species Act (ESA) — An act passed by Congress in 1973 intended to protect species and subspecies of plants and animals that are of “aesthetic, ecological, educational, historical, recreational and scientific value.” It may also protect the listed species’ “critical habitat”, the geographic area occupied by, or essential to, the protected species. The *U.S. Fish and Wildlife Service (USFWS)* and the *National Marine Fisheries Service (NMFS)* share authority to list endangered species, determine critical habitat and develop recovery plans for listed species. Currently, approximately 830 animals and 270 plants are listed as endangered or threatened nationwide at Title 50, Part 17, sections 11 and 12 of the Code of Federal Regulations. Further, under a settlement with environmental groups, USFWS has agreed to propose listing another 400 species over the next few years. The 1973 Endangered Species Act superseded and strengthened the *Endangered Species Preservation Act* of 1966 and the *Endangered Species Conservation Act* of 1969. The 1973 provisions required that the act be re-authorized by Congress every five years. Major provisions of the 1973 ESA included:

- [1] Emphasis on the conservation of ecosystems upon which species depend;
- [2] Consolidated existing U.S. and foreign lists;
- [3] Established and defined categories of “endangered” and “threatened”;
- [4] Lowered the listing threshold to “in danger of extinction in a significant portion of range”;
- [5] Made eligible all classes of vertebrates, invertebrates, and plants;
- [6] Defined and prohibited “take” of endangered vertebrates and invertebrates;
- [7] Established prohibitions on take of threatened species available by special regulation;
- [8] Restricted import and export;
- [9] Required federal agencies to undertake conservation programs;
- [10] Prohibited federal agencies from authorizing, funding, or carrying out actions that may jeopardize the continued existence of listed species;
- [11] Authorized the establishment of National Wildlife Refuges to protect habitat;
- [12] Established a state grant program; and
- [13] Appropriated funding for programs through 1978 (5-year cycle).

1978 amendments included:

- [1] Established cabinet level exception from jeopardy standard;
- [2] Critical habitat defined and designation required for listing;
- [3] Economic impacts considered when designating critical habitat;
- [4] Distinct population of vertebrates could be listed;
- [5] Required recovery plans for species listed as endangered; and
- [6] Appropriated funding for programs through 1982.

1982 amendments included:

- [1] Listing based solely on best biological information available;
- [2] Critical habitat designation concurrent with listing only to maximum extent prudent and determinable;
- [3] Established time requirements for listing process;
- [4] Established recovery priority system;

- [5] Designation of experimental populations;
- [6] Limited prohibition on take of endangered plants;
- [7] Incidental take permits for development of private land;
- [8] Incidental take provision incorporated within Biological Opinions; and
- [9] Appropriated funds for programs through 1988.

1988 amendments included:

- [1] Prohibited recovery preference based on *Taxonomy*;
- [2] Required monitoring of recovered and candidate species;
- [3] Established recovery plan content requirements;
- [4] Required public review and comment on recovery plans;
- [5] Required reporting of recovery expenditures and species status;
- [6] Strengthened take prohibitions for endangered plants; and
- [7] Appropriated funds for programs through 1992.

Also see *National Oceanic and Atmospheric Administration (NOAA)*.

Endangered Species Conservation Act — Passed in 1969, this act superseded the *Endangered Species Preservation Act* of 1966 and would eventually be replaced by the *Endangered Species Act (ESA)* of 1973. Major provisions of this act included:

- [1] Identified vertebrates and invertebrates in danger of worldwide extinction;
- [2] Prohibited interstate commerce of illegally taken species;
- [3] Prohibited import or subsequent sale within U.S. with only few exceptions; and
- [4] Required an international agreement on trade in endangered species.

Endangered Species Preservation Act — Passed in 1966, this represented the first legislated effort towards identification and protection of animal species in the United States threatened by extinction. It represented the forerunner of the *Endangered Species Act (ESA)* of 1973, but would first be replaced by the *Endangered Species Conservation Act* of 1969. Major provisions of this act included:

- [1] Identification of native vertebrates in danger of extinction;
- [2] Directed federal agencies to preserve habitat when “practicable and consistent”;
- [3] Authorized establishment of *National Wildlife Refuges* to protect habitat; and
- [4] Provided no protection except on refuges.

Endangerment Assessment — (1) A site-specific risk assessment of the actual or potential danger to human health or welfare and the environment from the release of hazardous substances or waste. The endangerment assessment document is prepared in support of enforcement actions under the *U.S. Environmental Protection Agency’s (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* or *Resource Conservation and Recovery Act (RCRA)*. (2) A study to determine the nature and extent of contamination at a site on the *National Priorities List* and the risks posed to public health or to the environment. The EPA or the state would conduct the study when a legal action is to be taken to direct potentially responsible parties to clean up a sit or pay for it. An endangerment assessment supplements a *Remedial Investigation (RI)*.

Endemic — (1) Something peculiar to a particular people or locality, such as a disease which is always present in the population. (2) (Ecology) Confined to, or *Indigenous* in, a certain area or region, as an endemic plant or animal.

Endemism — (Biodiversity Measure) Number of endemic species (and their abundance) at each taxonomic level and by species group (e.g., birds). This measure provides an index of enetic diversity and biome/biogeography diversity, and when compared with historical accounts provides and index of general trends in biological diversity.

Endocrine-Disrupting Chemicals — The *U.S. Environmental Protection Agency (EPA)* has defined an endocrine-disrupting chemical as “an exogenous natural or anthropogenic agent that produces reversible or irreversible adverse effects at the level of the individual, population and/or community by interfering with the synthesis, storage-release, secretion, transport-clearance, binding, action, or elimination of endogenous hormones in the body.” The endocrine system of vertebrate animals is made up of ductless glands, which produce hormones that are discharged into the blood or lymph system and circulated to all parts of the body. The endocrine glands include the pituitary gland; the thyroid, parathyroid, and adrenal glands; the islands of Langerhans of the pancreas; and the gonads. Endocrine-disrupting chemicals can mimic hormones by causing an exaggerated response, or they can block the effects of a hormone on the body. Endocrine disruptors can include natural estrogens (phytoestrogens and animal steroids), synthetic (xenobiotic) estrogens, or any number of pesticides and industrial chemicals such as halogenated aromatic hydrocarbons (HAHs), polycyclic aromatic hydrocarbons (PAHs), phthalates, and phenols. Also referred to as *Endocrine Disruptors*.

Endocrine Disrupters — See *Endocrine-Disrupting Chemicals*.

Endogenous — (Geology) Derived from within; geologic processes originating from internal causes within the earth or magma.

Endogenous Variable — (Statistics) Variables which are determined solely within the series of equations of the model. Also referred to as dependent variables as their values are assumed to be dependent upon the behavior of other pre-determined or explanatory variables, referred to as *Exogenous Variables*. An exception to this is a *Lagged Endogenous Variable*, which may also be an explanatory variable but whose value is determined within the system of equations by past values of the explanatory variables. For example, in the equation below, for any time period t (where $t=1, 2, \dots, n$),

$$Y_t = \alpha + \beta X_t + \delta Y_{t-1} + \varepsilon_t$$

where Y_t represents the endogenous variable, X_t represents the exogenous variable, and Y_{t-1} represents the lagged endogenous variable. Also referred to as the *Dependent Variable* or the variable to be explained (*Explained Variable*).

Endoreic — A term used to describe areas with terminal lakes and an interior drainage basin. Approximately 27 percent of the earth's total land surface is endoreic; only about 5 percent of the North American continent is endoreic.

Endosmosis, also Endosmotic — The inward flow of a fluid through a permeable membrane toward a fluid of greater concentration. Contrast with *Exosmosis* (*Exosmotic*).

Endrin — (Water Quality) A pesticide toxic to freshwater and marine aquatic life that produces adverse health effects in domestic water supplies.

Energy — The capacity to perform work, or the potential for power and activity; energy may be captured or held in living matter (e.g., food is stored energy). Various forms of energy include kinetic, potential, thermal, nuclear, rotational, and electromagnetic. *Hydroelectric* power, a form of potential energy, is derived from flowing water, typically by allowing water to be raised to, or maintained at, an elevated height and then release energy as it flows to a lower level.

Energy Dissipator — (1) A structure for slowing the fast moving spillway flows of a dam in order to prevent erosion of the stream channel below the dam. (2) An apron of rocks, logs, concrete baffles, or other materials that slows down water flowing through a culvert or ditch, or over a dam, and thereby reduces its erosive force.

Energy Grade Line (E.G.L.) — A line that represents the elevation of energy head of water flowing in a pipe, conduit or channel. The line is drawn above the hydraulic grade line (gradient) a distance equal to the velocity head ($V^2/2g$) of the water flowing at each section or point along the pipe or channel. Also see *Hydraulic Gradeline*.

Energy Gradient — The change in energy per unit length in the direction of flow or motion.

Energy Industry Use (Water) — The use of water in an amount in excess of one thousand acre-feet per year as a medium for carrying coal or other energy minerals, or in the extraction or refining of energy minerals.

Energy Industry User (Water) — A natural person, firm, partnership, association, syndicate, corporation, joint venture, public entity, or state or federal agency using or supplying water for energy industry use.

(National) Energy Policy Act (EPAct) — A federal act passed in 1992 that established maximum water-use standards for newly manufactured plumbing fixtures. According to the act, any tank-type toilet for household use manufactured after January 1, 1994, must use a maximum of 1.6 gallons per flush. The same requirement is mandatory for all tank-type toilets for commercial use manufactured beginning in 1997. The EPAct also sets water-use standards for all newly manufactured urinals (a maximum of one gallon per flush), kitchen and bath faucets, and showerheads.

Enforceable Requirements — Conditions or limitations in permits issued under the *Clean Water Act (CWA)*, Section 202 or 404, that, if violated, could result in the issuance of a compliance order or initiation of a civil or criminal action under federal or applicable state laws.

Enforce (Water Right) — Generally refers to the allocation of water resources in strict accordance with various terms and conditions specified by a water right, i.e., priority dates, amounts, etc.

Englacial — Located or occurring within a glacier.

Enhanced Oil Recovery — Techniques for the removal of the remaining thick, heavy oil from reservoirs after primary recovery and secondary recovery techniques have been used. Typically, steam is injected into the reservoir to reduce the viscosity and provide pressure to force the oil into collection wells.

Enhanced Rhizosphere Biodegradation — See *Phytoremediation* and *Rhizodegradation*.

Enhanced Surface Water Treatment Rule (ESWTR) — A proposed rule promulgated by the *U.S. Environmental Protection Agency (EPA)* to take effect in the year 2000 intended to reduce the number of *Crypto Oocysts* (*Cryptosporidium parvum*) found in raw water supplies used for drinking water.

Enhancement — (1) Emphasis on improving the value of particular aspects of water and related land resources. (2) Activities conducted in existing *Wetlands* or other aquatic resources which increase one or more aquatic functions.

Enjoin — To prohibit or forbid, especially by legal action.

Enlibra (Initiative) — A set of environmental policy principles prepared by the Western Governors' Association (WGA) that symbolizes balance and stewardship as a means for reconciling economic development with sustaining natural resources. The doctrine speaks to greater participation and collaboration by citizens in resources decision making and promotes the use of market forces as tools to achieve resource conservation goals. A goal of Enlibra is to encourage people on all sides of resources issues to respect different values and to give affected parties a role in designing and implementing solutions. Principles and characteristics of the doctrine include:

- [1] Greater participation and collaboration in decision making by citizens who believe natural resources can be protected while still using them;
- [2] Focusing on results and not on programs;
- [3] Using tools other than regulations to protect and improve resources management and environmental quality;
- [4] Allowing local solutions for meeting national standards;
- [5] Replacing confrontation with collaboration;
- [6] Using science instead of subjectivity for policy making;
- [7] Using cost-effective means for achieving benefits;
- [8] Managing resources according to natural boundaries, not political or administrative ones.

[Source Information: Western Governors' Association, February 24, 1998, Policy Resolution 98-001] Also see for comparisons and contrasts, *Basin Management*, *Ecosystem Management*, *Integrated Resource Planning (IRP)*, *Holistic, Watershed Management* and *Watershed Planning*.

Enrichment — The addition of nutrients, such as nitrogen and phosphorus and carbon compounds, into a lake or waterway to the point that the *Trophic Level* is greatly increased because of the stimulation of the growth of algae and other aquatic plants.

Ensaline (Euhaline) — Salinity approximating seawater (33 parts per million).

Enteric — Of intestinal origin, especially applied to wastes or bacteria.

Enteric Fever — An acute, highly infectious disease caused by a bacillus (*Salmonella typhi*) transmitted chiefly by contaminated food or water and characterized by high fever, headache, coughing, intestinal hemorrhaging, and rose-colored spots on the skin. More commonly referred to as *Typhoid Fever*.

Enteric Viruses — A category of viruses related to human excreta found in waterways.

Enterococcus Bacteria — Bacteria commonly found in the feces of humans and other warm-blooded animals. Their presence in water is considered to verify fecal pollution. They are characterized as gram-positive, cocci bacteria that are capable of growth in brain-heart infusion broth. In the laboratory, they are defined as all the organisms that produce red or pink colonies within 48 hours at 35 degrees Celsius plus or minus 1 degree Celsius on KF-streptococcus medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100mL of sample.

Enterovirus — A virus whose presence may indicate contaminated water; a virus which may infect the gastrointestinal tract of humans.

Entitlement — (1) The right to receive, demand or do something, as a water entitlement. (2) The annual maximum amount of water which can be delivered to a parcel of land, a product of eligible acres and water duty (expressed in acre-feet per year).

Entrain — To trap bubbles in water either mechanically through turbulence or chemically through a reaction.

Entrainment — (Streams) (1) To be moved by water motion involuntarily. (2) The picking up and transporting of materials by currents. (3) The transferring and mixing of water masses by friction between opposing currents. (4) The incidental trapping of fish and other aquatic organisms in the water, for example, used for cooling electrical power plants or in waters being diverted for irrigation or similar purposes.

Entrance Head — The *Head* required to cause flow into a conduit or other structure, including both entrance loss and *Velocity Head*.

Entrapment Zone — An area of an estuary or other watercourse where seaward-flowing fresh water overlays more dense, saline ocean water resulting in a two-layer mixing zone characterized by *Flocculation*, aggregation, and accumulation of suspended materials from upstream.

Entrenched Meander — (1) An old meander that is more or less enclosed by valley walls and has been deepened vertically downward, below the surface of the valley in which it was originally formed. (2) Streams which have reached the advanced stage of one cycle hold their courses in the second cycle and cut down in the old meanders; the result is a meandering stream in a young valley. Also referred to as an *Inherited Meander*.

Entrenched Stream — A stream flowing in a narrow trench or valley that has been cut into a relatively level upland or plain.

Entropy — (1) A measure of the unavailable energy in a system, i.e., energy that cannot be converted into another form of energy.

(2) A measure of the mixing of different kinds of sediment; high entropy is approach to unmixed sediment of one kind.

Environment — (1) The aggregate of surrounding things, conditions or influences, especially as affecting the existence or development of people or of nature. (2) The natural and physical environment, excluding social, economic, and other environments. (3) All of the external factors, conditions, and influences which affect the growth, development, and survival of organisms or a community. The components of an environment include climate, physical, chemical, and biological factors, nutrients, and social and cultural conditions. These influences affect the form and survival of individuals and communities. (4) The aggregate of all the surrounding conditions, influences, or forces affecting a locus of sedimentation.

Environmental Analysis — (1) An analysis of alternative actions and their predictable short and long-term environmental effects, which may include physical, biological, economic, social and environmental design factors and their interaction. (2) (NEPA) Systematic process for considering environmental factors in resource management actions.

Environmental Assessment (EA) [NEPA/EPA] — (1) A concise analysis to assist federal government agencies in determining whether there is potential for significant environmental aspects associated with the proposed action and whether an environmental impact statement is required. (2) An environmental analysis prepared pursuant to the *National Environmental Policy Act (NEPA)* and the *U.S. Environmental Protection Agency (EPA)* that presents the first thorough examination of alternative plans to positively demonstrate that the environmental and social consequences of an applicable project or action were considered. If it is determined that proposed actions would not have a significant impact on the environment, then a *Finding of No Significant Impact (FONSI)* would be issued. If it is shown that such activities do, in fact, significantly impact the environment or are otherwise deemed controversial, then an *Environmental Impact Statement (EIS)* will normally be required.

Environmental Audit [NEPA/EPA] — (1) An internal investigation of company compliance with environmental regulations. (2) A study of a site prior to a real estate transaction to uncover potential environmental liability associated with the property, such as the prior improper disposal of hazardous wastes into the ground. (3) An independent assessment (not conducted by *U.S. Environmental Protection Agency (EPA)*) of the current status of a party's or facility's compliance with applicable environmental requirements or of a party's environmental compliance policies, practices, and controls. Many pollution prevention initiatives require an audit to determine where wastes may be reduced or eliminated or energy conserved. Many supplemental environmental projects that offset a penalty use audits to identify ways to reduce the harmful effects of a violation.

Environmental Defense Fund (EDF) — A national, non-profit environmental and conservation organization active in legal, economic, and scientific aspects of environmental issues. The EDF employs scientists, attorneys, economists, computer modelers, and other environmental professionals whose purpose is to propose practical and economically feasible solutions to major environmental problems. The EDF has been responsible for a number of important environmental law cases coming to the attention of the courts in the United States. The EDF is headquartered in New York City and has six other offices across the United States. The EDF was founded in the early 1970s when scientists documented the effects of the pesticide DDT on humans,

wildlife, and the environment. The EDF subsequently joined with scientists and attorneys and successfully campaigned to have DDT banned nationwide in 1972. Currently, major EDF projects include: (1) limiting the greenhouse effect and climate change; (2) improving air quality; (3) tracing and blocking the sources of ocean pollution; (4) enforcing and extending the *Endangered Species Act (ESA)*; (5) limiting chemical pollution and its effects on human health and the environment; (6) promoting water and energy conservation; (7) encouraging recycling and the reduction of solid waste; and (8) protecting endangered land areas such as Antarctica and the rain forests in Brazil, West Africa, and Indonesia.

Environmental Equity — Equal protection from environmental hazards for individuals, groups, or communities regardless of race, ethnicity, or economic status.

Environmental Evaluation — That part of the planning process by governmental agencies that inventories and estimates the potential effects on the human environment of alternative solutions to resource problems, determines the need for an *Environmental Assessment (EA)* or an *Environmental Impact Statement (EIS)*, and aids in the consideration of alternatives and the identification of available resources.

Environmental Impact Statement (EIS) [NEPA/EPA] — (1) A document prepared by or for the *U.S. Environmental Protection Agency (EPA)* of the likely environmental consequences of a proposal for a major federal action that is to be considered in deciding whether to approve the proposal. It includes a review of the affected environment, a description of any adverse environmental effects which cannot be avoided if the proposal is adopted, alternatives to the proposed action (including a no action alternative), actions taken to avoid environmental harm or otherwise to better the environment, and environmental considerations and actions by the other participating nations, bodies or organizations. (2) A report required by Section 102(2)(c) of Public Law 91–190, *National Environmental Policy Act (NEPA)*, for all major projects which significantly impact on the quality of the human environment or are environmentally controversial. The EIS is a detailed and formal evaluation of the favorable and adverse environmental and social impacts of a proposed project and its alternatives. A tool for decision making, the EIS describes the positive and negative effects of an undertaking and cites possible, less environmentally disruptive alternative actions. Also see *Environmental Assessment (EA)*.

Environmental Indicator — A measurement, statistic or value that provides a proximate gauge or evidence of the effects of environmental management programs or of the state or condition of the environment. See *Geoindicators [U.S. Global change Research Information Office]*. Sometimes used synonymously with *Ecological Indicator*.

Environmental Indicators (RCRA) [EPA] — Two corrective action environmental indicators – (a) Current Human Exposures Under Control and (b) Migration of Contaminated Groundwater Under Control – that are measures of program progress and are being used by the *U.S. Environmental Protection Agency (EPA)* to track whether it is meeting the goals set under the Government Performance and Results Act (GPRA). In general terms, these measures indicate current “environmental conditions” and specifically whether people are currently being exposed to environmental contamination at unacceptable levels, and whether any existing plumes of contaminated groundwater are getting larger or adversely affecting surface water bodies. Environmental indicator guidance for the *Resource Conservation and Recovery Act (RCRA)* Corrective Action Program information is available at “<http://www.epa.gov/correctiveaction/eis.htm>.”

Environmental Justice — The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population should be forced to shoulder a disproportionate share of exposure to the negative effects of pollution due to lack of political or economic strength.

Environmental Manipulation — Actions taken directly or indirectly by man to alter the natural characteristics and evolving patterns of an *Ecosystem* through alterations to plant or animal life, or habitat conditions.

(United States) Environmental Protection Agency (EPA) — The U.S. Environmental Protection Agency (EPA) is responsible for implementing the federal laws designed to protect the environment. EPA endeavors to accomplish its mission systematically by proper integration of a variety of research, monitoring, standard-setting, and enforcement activities. As a complement to its other activities, EPA coordinates and supports research and anti-pollution activities of state and local governments, private and public groups, individuals, and educational institutions. EPA also monitors the operations of other Federal agencies with respect to their impact on the environment. EPA was created through Reorganization Plan #3 of 1970, which was devised to consolidate the federal government’s environmental regulatory activities into a single agency. The plan was sent by the President to Congress on July 9, 1970, and the agency began operation on December 2, 1970. EPA was formed by bringing together 15 components from 5 executive departments and independent agencies. Air pollution control, solid waste management, radiation control, and the drinking water program were transferred from the Department of Health, Education, and Welfare (now the Department of Health and Human Services). The federal water pollution control program was taken from the Department of the Interior, as was part of a pesticide research program. From the Department of Agriculture, EPA acquired authority to register pesticides and to regulate their use, and from the Food and Drug Administration, EPA inherited the responsibility to set tolerance levels of pesticides in food. EPA was assigned some responsibility from the Atomic Energy Commission, and absorbed the duties of the Federal Radiation Council. The enactment of major new environmental laws and important amendments to older laws in the 1970s and 1980s greatly expanded EPA’s responsibilities. The agency now administers ten comprehensive environmental protection laws:

- [1] Clean Air Act (CAA)
- [2] Clean Water Act (CWA)
- [3] Safe Drinking Water Act (SDWA)
- [4] Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or “Superfund”)
- [5] Resource Conservation and Recovery Act (RCRA)
- [6] Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

- [7] Toxic Substances Control Act (TSCA)
- [8] Marine Protection, Research, and Sanctuaries Act (MPRSA)
- [9] Uranium Mill Tailings Radiation Control Act (UMTRCA)
- [10] Pollution Prevention Act

The primary mandates for the water-related programs administered through the EPA Water Management Division are the *Federal Water Pollution Control Act (Public Law 92-500)*, as amended, commonly referred to as the *Clean Water Act (CWA)*, and the *Safe Drinking Water Act (SDWA – Public Law 93-523)*. The CWA addresses the discharge of pollutants from point and nonpoint sources into waters of the United States (as defined). The goal of the SDWA is to protect public health over lifetime exposure to drinking water by ensuring that the source water as well as the system storage distribution and service lines are free and protected from contamination. EPA water-related programs establish national and regional objectives, promote delegation of programs to states (primacy), and support that delegation in a manner that ensures achievement of required objectives. Also see *Science Advisory Board (SAB)*. The Environmental Protection Agency's headquarters is in Washington, D.C. where overall planning, coordination, and control of EPA programs is conducted. The EPA's organization structures is as follows:

- [1] **Office of the Administrator (OA)** – The Administrator is responsible to the President for providing the overall supervision and direction of the agency. The Office of the Administrator is supported by a Deputy Administrator; and three Associate Administrators for Regional Operations and State/Local Relations, Communications, Education, and Public Affairs, and Congressional and Legislative Affairs. The Office of the Administrator is also composed of staff offices including: Administrative Law Judges, Civil Rights, Small and Disadvantaged Business Utilization, Science Advisory Board, Executive Support, Cooperative Environmental Management, Executive Secretariat, and the Pollution Prevention Planning Staff.
- [2] **Office of Administration and Resources Management (OARM)** – The Office of the Assistant Administrator for Administration and Resources Management has primary responsibility for policy and procedures governing resources management, human resources management, environmental health and safety, facilities management, administrative services, organization and management analysis, systems development, information management services, automated data processing systems, and procurement through contracts and grants. In performance of the above functions and responsibilities, the Assistant Administrator represents the Administrator in communications with the Office of Management and Budget, the Office of Personnel Management, the General Accounting Office, the General Services Administration, the Department of Treasury, and other federal agencies prescribing requirements for the conduct of government budget, fiscal, management, and administrative activities.
- [3] **Office of Enforcement (OE)** – The Office of the Assistant Administrator for Enforcement serves as the primary advisor to the Administrator in matters concerning enforcement and provides the principal direction and review of civil enforcement activities for air, water, waste, pesticides, toxic substances, and radiation. The Office manages a national criminal enforcement program; ensures coordination of media office administrative compliance programs and civil/criminal enforcement activities; provides technical expertise for enforcement activities to headquarters, regions, and states through the National Enforcement Investigations Center; and manages the program for assuring compliance by federal facilities with all environmental implementing regulations.
- [4] **Office of General Counsel (OGC)** – The Office of General Counsel provides legal services to all of the organizational elements of the agency with respect to all programs and activities of the agency; provides legal opinions, legal counsel, and litigation support; and assists in the formulation and administration of the agency's policies and programs as legal advisor.
- [5] **Office of Policy, Planning, and Evaluation (OPPE)** – The Office of the Assistant Administrator for Policy, Planning, and Evaluation serves as the agency's focal point for oversight and coordination of all policy, program guidance, and evaluation functions. The office is responsible for policy and economic analysis, regulatory management and evaluation, and strategic planning.
- [6] **Office of International Activities (OIA)** – The Office of the Assistant Administrator for International Activities performs the primary role in developing and maintaining a sophisticated understanding of the international political climate that will influence domestic and international consideration of environmental problems. The office advised the administrator on the most appropriate timing, forum, and other modalities for dealing with international environmental issues, and exercises the lead responsibility within EPA for devising strategies to advance the U.S. position. The office manages meetings with representatives of other governments and multilateral organizations consistent with such strategies.
- [7] **Office of Inspector General (OIG)** – The Office of Inspector General conducts audits and investigations relating to programs and operations of EPA; provides leadership and coordination; and recommends policies for agency activities to promote economy and efficiency, and to prevent and detect fraud and abuse. The Office informs agency senior management and the Congress of serious problems, abuses, and deficiencies relating to EPA programs and operations, and of the necessity for and progress of correction action.
- [8] **Office of Water (OW)** – The Office of the Assistant Administrator for Water is responsible for the agency's water quality activities, which represent a coordinated effort to restore the nation's waters. The functions of this program include development of national programs, technical policies, and regulations relating to drinking water, water quality, and groundwater; environmental and pollution sources standards development; wetlands protection; technical direction, support, and evaluation of regional water activities; enforcement of standards; development of technical assistance and technology transfer programs; provision of training in the field of water quality; economic and long-term environmental analysis; and marine/estuarine protection.

- [9] **Office of Solid Waste and Emergency Response (OSWER)** – The Office of the Assistant Administrator for Solid Waste and Emergency Response provides agencywide policy, guidance, and direction for the agency's solid waste and emergency response programs. The office is responsible for the development of guidelines and standards for the land disposal of hazardous wastes and for underground storage tanks; technical assistance in the development, management, and operation of solid waste management activities; analyses on the recovery of useful energy from solid waste; development and implementation of a program to respond to hazardous waste sites and spills; and the enforcement of applicable laws and regulations.
- [10] **Office of Air and Radiation (OAR)** – The Office of the Assistant Administrator for Air and Radiation is responsible for the air activities of the agency, which include development of national programs, technical policies, and regulation for air pollution control; development of national standards for air quality, emission standards for new stationary sources, and emission standards for hazardous pollutants; technical direction, support and evaluation of regional air activities; enforcement of standards; and provision of training in the field of air pollution control. Related activities include technical assistance to states and agencies having radiation protection programs, and a national surveillance and inspection program for measuring radiation levels in the environment.
- [11] **Office of Prevention, Pesticides and Toxic Substances (OPPTS)** – The Office of the Assistant Administrator for Prevention, Pesticides, and Toxic Substances is responsible for the development of national strategies for the control of toxic substances; criteria for assessing chemical substances; standards for test protocols for chemicals; rules and procedures for industry reporting and regulations for the control of substances deemed to be hazardous to man or the environment; enforcement of standards; and evaluating and assessing the impact of new chemicals and chemicals with new uses to determine the hazard and, if needed, develop appropriate restrictions. It coordinates activities on the assessment of control of toxic substances. Additional activities include control and regulation of pesticides and reduction in their use to assure human safety and protection of environment quality; establishment of tolerance levels for pesticides which occur in or on food; monitoring of pesticides residue levels in food, humans, and nontarget fish and wildlife and their environments; investigation of pesticide accidents; and coordination of the agency pollution prevention program.
- [12] **Office of Research and Development (ORD)** – The Office of the Assistant Administrator for Research and Development is responsible for the research and development needs of the agency's operating programs and the conduct of an integrated research and development program for the agency. The Assistant Administrator for Research and Development serves as the agency's principal science advisor and is responsible for the development, direction, and conduct of a national environmental research, development, and demonstration program in health risk assessment, health effects, engineering and technology, processes and effects, acid rain deposition, monitoring systems and policy, standards, and regulations. The office provides for dissemination of scientific and technical knowledge, including analytical methods, monitoring techniques, and modeling methodologies; and provides technical and scientific advice on agencywide technical program issues.

EPA Regional Offices (headquarters location) and the states/areas administered:

- [1] **EPA Region 1** (Boston, Massachusetts) – Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont.
- [2] **EPA Region 2** (New York, New York) – New Jersey, New York, Puerto Rico, Virgin Islands.
- [3] **EPA Region 3** (Philadelphia, Pennsylvania) – Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia.
- [4] **EPA Region 4** (Atlanta, Georgia) – Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee.
- [5] **EPA Region 5** (Chicago, Illinois) – Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin.
- [6] **EPA Region 6** (Dallas, Texas) – Arkansas, Louisiana, New Mexico, Oklahoma, Texas.
- [7] **EPA Region 7** (Kansas City, Kansas) – Iowa, Kansas, Missouri, Nebraska.
- [8] **EPA Region 8** (Denver, Colorado) – Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming.
- [9] **EPA Region 9** (San Francisco, California) – Arizona, California, Hawaii, Nevada, American Samoa, Guam, Trust Territories of the Pacific.
- [10] **EPA Region 10** (Seattle, Washington) – Alaska, Idaho, Oregon, Washington.

EPA Field Offices:

- [1] **Environmental Research Centers**
Las Vegas, Nevada
Research Triangle Park, North Carolina
Cincinnati, Ohio
Corvallis, Oregon
- [2] **Administration and Resources Management Offices**
Research Triangle Park, North Carolina
Cincinnati, Ohio
- [3] **National Enforcement Investigations Center**
Denver, Colorado

Environmental Resistance — The limiting effect of environmental conditions on the numerical growth of a population.

Environmental Response Team (ERT) [EPA] — U.S. Environmental Protection Agency's (EPA) group of highly trained scientists

and engineers based in Edison, New Jersey, and Cincinnati, Ohio, who back up the federal On-Scene Coordinator. The ERT's capabilities include multimedia sampling and analysis, hazard assessment, hazardous substance and oil spill cleanup techniques, and technical support.

Environmental Review — An analysis of the likely environmental consequences of the action that is to be considered in the decision making process. It includes a review of the affected environment, actions taken to avoid environmental harm or otherwise to better the environment, and environmental considerations and actions by the other participating nations, bodies, or organizations. Environmental reviews will be prepared either unilaterally or in conjunction with another U.S. agency, but do not include foreign government participation.

Environmental Study — An analysis of the likely environmental consequences of the action that is to be considered in the decision making process. It includes a review of the affected environment, actions taken to avoid environmental harm or otherwise to better the environment, and environmental considerations and actions by the other participating nations, bodies, or organizations. Environmental studies will be prepared by the United States in conjunction with one or more foreign nations, or by an international body or organization in which the U.S. is a member or participant.

Environmental Water — The water for wetlands, the instream flow for a major river (based on the largest fish flow specified in an entire reach of that river) or, for wild and scenic rivers, the amount of water based on unimpaired natural flow. Also referred to as *Dedicated Natural Flows*.

Environmentalism — Advocacy for or work toward protecting the natural environment from destruction or pollution.

Enzyme — (1) Organic substances (produced by living organisms) which cause or speed up chemical reactions. Organic catalysts and/or biochemical catalysts. (2) Any of numerous proteins or conjugated proteins produced by living organisms and functioning as biochemical catalysts. Specifically, an organic catalyst that accelerates (catalyzes) specific transformations of material in plants and animals. Enzymes are elaborated by cells, but their action is independent of life processes and they are not consumed in the course of their action. They occur in all tissues, particularly in digestive secretions, and are of greatest importance for the cellular processes or the digestion and utilization of food.

Eolian — Pertaining to the wind; especially said of rocks, soils, and deposits (such as loess, dune sand, sand from volcanic tuffs) whose constituents were transported (blown) and laid down by atmospheric currents, or of landforms produced or eroded by the wind, or of sedimentary structures (such as ripple marks) made by the wind, or of geologic processes (such as erosion and deposition) accomplished by the wind.

Eolian Soil Material — Soil material accumulated through wind action.

EPA — See (*United States*) *Environmental Protection Agency (EPA)*.

Epeiric Sea — (Oceanography) A shallow inland sea having only a restricted connection to the ocean, such as Hudson Bay.

Ephemeral Stream — (1) A stream that flows only in direct response to precipitation, and thus discontinues its flow during dry seasons. Such flow is usually of short duration. (2) An intermittent stream which flows only in direct and immediate response to precipitation, and has no prolongation of flow from surface or underground storage. Most of the dry washes of more arid regions may be classified as ephemeral streams. (3) An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Run-off from rainfall is the primary source of water for stream flow. (4) A stream whose channel lies above the water table and that flows only during or immediately after periods of precipitation. Also see *Stream*.

Epicontinental Marginal Sea — (Oceanography) A shallow part of the ocean that overlies a *Continental Shelf* and is partially enclosed by islands or by extensions of the mainland.

Epicontinental Sea — (Oceanography) A general term referring to either an *Epicontinental Marginal Sea* or an *Epeiric Sea*.

Epidemic — Widespread outbreak of a disease, or a large number of cases of a disease in a single community or relatively small area. Disease may spread from person to person, and/or by the exposure of many persons to a single source, such as a water supply.

Epidemiologic Study — The study of human populations to identify causes of disease. Such studies often compare the health status of a group of persons who have been exposed to a suspect agent with that of a comparable non-exposed group.

Epidemiology — (1) The study of the incidence, transmission, distribution, and control of infectious disease (including waterborne disease) in large populations. (2) A branch of medicine which studies epidemics (diseases which affect significant numbers of people during the same time period in the same locality). The objective of epidemiology is to determine the factors that cause epidemic diseases and how to prevent them.

Epifauna — (Ecology) Benthic animals living on the sediment or among rocks and other structures.

Epilimnion — (1) The upper layer of water in a thermally stratified lake or reservoir. This layer consists of the warmest water and has a fairly uniform (constant) temperature. The layer is readily mixed by wind action. (2) The relatively warm and uniformly mixed uppermost layer of water in a lake, especially the less dense, oxygen-rich upper layer of a thermally stratified lake. (3) The warm upper layer of a body of water with thermal stratification, which extends down from the surface to the *Thermocline*, which forms the boundary between the warmer upper layers of the epilimnion and the colder waters of the lower depths, or *Hypolimnion*. The epilimnion is less dense than the lower waters and is wind-circulated and essentially homothermous. Also see *Thermal Stratification*, *Fall Overturn*, and *Spring Overturn*.

Epimeritic — (Oceanography) Of or relating to the very top of the *Neritic Zone*, at and just below the surface, down to a depth of 40 meters.

Epipelagic Zone — (Oceanography) The upper zone of the ocean, down to about 200 meters, the maximum depth for photosynthesis.

Epipelic — (Ecology) Of or relating to organisms that inhabit the surfaces of water or sediment, or where water and sediment meet.

Epiphyte — A plant that grows on another plant but is not a parasite and produces its own food by photosynthesis, as certain orchids, mosses, and lichens; an air plant.

Epithermal — A *Hydrothermal* mineral deposit formed within approximately one kilometer (0.6 mile) of the earth's surface and in the temperature range of 50EC (122EF) to 200EC (392EF).

Epithermal Ore Deposits — Ore deposits formed in and along fissures or other openings in rocks by deposition at shallow depths from ascending hot solutions.

EPT — A group of three orders of insects – *Ephemeropter* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies) – are generally considered as sensitive to pollution and are therefore used in some cases as primary indicators (*Indicator Species*) of stream aquatic integrity.

Equal Discharge Increment (EDI) — A method used in measuring suspended sediment in a stream wherein samples are obtained at the centroids of equal discharge increments. This method requires knowledge of the flow distribution in the stream cross section, but can save time over the *Equal Transit Rate (ETR)* method because fewer verticals are required.

Equal Footing Doctrine [U.S. Constitution] — A provision of the U.S. Constitution which provides to each state the title to tidelands and the beds of *Navigable* lakes and streams within its borders. In conjunction with the *Public Trust Doctrine*, which is generally recognized in some form by most states, these provisions embody the principle that the state holds title to such properties within the state in trust for the beneficial use of all its citizens and that public rights of access to and for the use of tidelands and navigable waters are inalienable. Traditional public trust rights include navigation, commerce, and fishing, and in some cases have been extended to include protection of fish and wildlife, preserving trust lands in their natural condition for scientific study and scenic enjoyment, and related open-space uses.

Equal Transit Rate (ETR) — A method used in measuring *Suspended Sediment* in a stream wherein the sample volume taken is proportional to the streamflow at each of several equally spaced verticals. This technique results in a gross sample proportional to the total streamflow.

Equilibrium, Calcium Carbonate — (Water Treatment) A water is considered stable when it is just saturated with calcium carbonate. In this condition the water will neither dissolve nor deposit calcium carbonate. Thus, in this water the calcium carbonate is in equilibrium with the hydrogen ion concentration.

Equilibrium Condition — As used in the chemical sense, a state in which there are no changes in the relative concentrations of the chemical species present in a system. The specific relationship is given by the equilibrium constant for the reaction of interest. Used in reference to a groundwater system it describes a condition in which all inputs (of water) equal all outputs. The *Groundwater Table* is neither rising nor falling under equilibrium conditions.

Equilibrium Constant — A value which describes the relationship between chemical species in a system at equilibrium. The value of the constant is dependent upon temperature.

Equilibrium Drawdown — The ultimate constant drawdown for a steady rate of pumped discharge.

Equilibrium Line — The boundary between the *Accumulation Area* and the *Ablation Area* on a *Glacier*.

Equilibrium Profile — See *Profile of Equilibrium*.

Equilibrium Surface Discharge — The steady rate of surface discharge which results from a steady rate of net rainfall over a long period, with the discharge rate equal to the net rainfall rate.

Equilibrium Theory — (Oceanography) An ocean water model that assumes an ideal earth completely and uniformly covered by water of considerable depth, and also assumes that the water responds instantly to the tide-producing forces of the sun and moon to form a surface in equilibrium; this model does not take into account any of the other actual tidal components, such as inertia, the *Coriolis Effect*, friction, or irregular distribution of land masses.

Equilibrium Time — The point in time when flow conditions become substantially equal to those corresponding to *Equilibrium Surface Discharge* or *Equilibrium Drawdown*.

Equinoctial — A violent storm of wind and rain occurring at or near the time of the equinox.

Equipotential Line — A line in a field of flow such that the total head is the same for all points on the line; therefore, the direction of flow is perpendicular to the line at all points.

Equipotential Surface — A surface (or line) in a three-dimensional ground-water flow field such that the total hydraulic head is the same everywhere on the surface.

Ericophyte — (Ecology) A plant that grows in marshy, wetland areas.

Erodible — Susceptible to *Erosion*.

Erosion — (1) Detachment of soil particles under the influence of water and/or wind. The removal of dirt particles from the ground, streambed, or streambank by either wind, rain, or storm water runoff. (2) The wearing away and removal of materials of the earth's crust by natural means. (3) The wearing away of soil by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging. (4) Wearing away of soil by aging, water, wind, or ice; erosion is the process by which the earth's surface is shaped and occurs even in remote, uninhabited areas at a slow rate (geologic erosion); of more concern is accelerated erosion caused by people's activities. (5) The process by which flood waters lower the ground surface in an area by removing upper layers of soil. As usually employed, the term includes weathering, solution, corrosion, and transportation. The agents that accomplish the transportation and cause most of the wear are running water, waves, moving ice, and wind currents. Most writers include under the term all the mechanical and chemical agents of weathering that loosen rock fragments before they are acted on by the transportation agents; a few authorities prefer to include only the destructive effects of the transporting agents. Various types of water erosion include:

- [1] **Accelerated** – Erosion much more rapid than normal, natural, or geologic erosion, primarily as a result of the influence of the activities of man or, in some cases, of other animals or natural catastrophes that expose bare surfaces, for example, forest fires;
- [2] **Geological** – The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of floodplains, coastal plains, etc., and also referred to

- as natural erosion;
- [3] **Gross** – A measure of the potential for soil to be dislodged and moved from its place of origin, not necessarily the amount of soil that actually reaches a stream or lake, but the amount of soil that can be calculated from water and wind equations;
 - [4] **Gully** – The erosion process whereby water accumulates in narrow channels and, over short periods of time, removes soil from this narrow area to considerable depths, ranging from 1–2 feet (0.3–0.6 meters) to as much as 75–100 feet (23–31 meters);
 - [5] **Natural** – The wearing away of the earth’s surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man, and also referred to as geological erosion;
 - [6] **Normal** – The gradual erosion of land used by man that does not greatly exceed natural erosion;
 - [7] **Overfall** – Erosion caused by water flowing over an overfall;
 - [8] **Rill** – An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils and/or recent cuts and fills;
 - [9] **Sheet** – The removal of a thin, fairly uniform layer of soil from the land surface by runoff waters;
 - [10] **Shore** – Removal of soil, sand, or rock from the land adjacent to a body of water due to wave action;
 - [11] **Splash** – The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface runoff;
 - [12] **Streambank** – Scouring of material and the cutting of channel banks by running water;
 - [13] **Streambed** – Scouring of material and cutting of channel beds by running water;
 - [14] **Undercutting** – Removal of material at the base of a steep slope, overfall, or cliff by falling water, a stream, wind erosion, or wave action; the removal steepens the slope or produces an overhanging cliff.
- Erosion Ballon** — A metaphorical term for commonly obovately shaped, eroded sideslope areas that normally empty into an incised drainage way and are surrounded by non-eroded sideslopes.
- Erosion, Bank** — Destruction of land areas bordering rivers or water bodies by the cutting or wearing action of waves or flowing water.
- Erosion, Beach** — The retrogression of the shore line of large lakes and coastal waters caused by wave action, shore currents, or natural causes other than *Subsidence*.
- Erosion Control** — Materials, structures, and actions utilized and taken to reduce or prevent erosion.
- Erosion, Gross** — The total of all sheet, gully, and channel erosion in a drainage basin, usually expressed in units of mass.
- Erosion, Gully** — The widening, deepening, and headcutting of small channels and waterways due to erosion.
- Erosion Hazard** — A predictive rating of the erosion potential for a specific soil or location.
- Erosion Potential** — A ranking of a soil’s potential to erode.
- Erosion Ridge** — One of a series of small ridges formed on a snow surface by the abrasive action of particles carried by windblown snow.
- Erosion, Rill** — Removal of soil by running water with formation of shallow channels that can be smoothed out completely by normal cultivation (tillage).
- Erosion, Sheet** — The removal of a fairly uniform layer of soil or materials from the land surface by the action of rainfall and runoff water.
- Erosion Control** — The application of necessary measures including artificial structures, vegetative manipulation, water control, or physical soil changes to minimize soil erosion.
- Erosion Flood Plain** — A flood plain that has been created by the lateral erosion and the gradual retreat of the valley walls.
- Erosive** — The action of wind or water having sufficient velocity to cause *Erosion*. Not to be confused with *Erodible* as a quality of soil.
- ESA (Endangered Species Act)** — An act passed by Congress in 1973 intended to protect species and subspecies of plants and animals that are of “aesthetic, ecological, educational, historical, recreational and scientific value.” It may also protect the listed species’ “critical habitat”, the geographic area occupied by or essential to the species. The *U.S. Fish and Wildlife Service (USFWS)* and the *National Marine Fisheries Service (NMFS)* share authority to list endangered species, determine critical habitat and develop recovery plans for listed species. As of July, 1993, nationwide, some 728 plants and animals were on the federal threatened or endangered list. Further, under a settlement with environmental groups, USFWS has agreed to propose listing another 400 species over the next few years.
- Escarpment** — A steep slope or long cliff that results from erosion or faulting and separates two relatively level areas of differing elevations; the topographic expression of a fault.
- Escherichia Coli (E. Coli)** — A bacterial species which inhabits the intestinal tract of man and other warm-blooded animals. Although it poses no threat to human health, its presence in drinking water does indicate the presence of other, more dangerous bacteria. Specifically, *E. coli* are a member species of the fecal coliform group of indicator bacteria. In the laboratory, they are defined as those bacteria that produce yellow or yellow-brown colonies on a filter pad saturated with urea substrate broth after primary culturing for 22 to 24 hours at 44.5 degrees Celsius on mTEC medium. Their concentrations are expressed as number of colonies per 100 mL of sample.
- Esker** — A narrow ridge of gravelly or sandy glacial outwash material deposited by a stream in an ice tunnel within a glacier. Also referred to as *os3*.
- Espalier Drainage Pattern** — See *Trellis Drainage Pattern*.
- Established** — A plant firmly rooted and producing a good growth of leaves.
- Ester** — A compound formed by the reaction between an acid and an alcohol with the elimination of a molecule of water.

Estuaries — Drainage channels adjacent to the sea, frequently the lower courses of streams, which are subject to the periodic rise and fall of tides. See *Estuary*.

Estuarine — (1) Of, pertaining to, or formed in, an *Estuary*. (2) Something living in an inlet or river mouth, where tides flow through. (3) One of the classification systems under the *Wetlands* and *Deepwater Habitats* classification system. See *Wetlands* and *Wetlands and Deepwater Habitats* for additional information on this classification system and specific characteristics of Estuarine Systems.

Estuarine Environment — (Oceanography) The physical conditions that characterize an *Estuary*.

Estuarine Oceanography — (Oceanography) The study of the physical, geological, chemical, and biological characteristics of estuaries.

Estuarine Waters — Deepwater tidal habitats and tidal wetlands that are usually enclosed by land but have access to the ocean and are at least occasionally diluted by freshwater runoff from the land (such as bays, mouths of rivers, salt marshes, lagoons, etc.).

Estuarine Zone — The area near the coastline that consists of estuaries and coastal saltwater wetlands.

Estuary — (1) A complex ecosystem between a river and near-shore ocean waters where fresh and salt water mix. These brackish areas include bays, mouths of rivers, salt marshes, wetlands, and lagoons and are influenced by tides and currents. Estuaries provide valuable habitat for marine animals, birds, and other wildlife. (2) An estuary is a partially enclosed body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the salty sea water. The *Coastal Zone Management Act* of 1972 defines an estuary as “that part of a river or stream or other body of water having unimpaired connection with the open sea, where the sea-water is measurably diluted with freshwater derived from land drainage.” Estuaries and the lands surrounding them are places of transition from land to sea, and from fresh water to salt water. Although influenced by the tides, estuaries are protected from the full force of ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand that define an estuary’s seaward boundary. No one geographic shape defines an estuary, and they go by many different names, most often known as bays, lagoons, harbors, inlets, or sounds. However, the defining feature of an estuary is the mixing of fresh and salt water, not the name. Consequently, not all water bodies by these names are necessarily estuaries. Some familiar examples of estuaries include San Francisco Bay, Puget Sound, Chesapeake Bay, Boston Harbor, and Tampa Bay. The tidal, sheltered waters of estuaries support unique communities of plants and animals, specially adapted for life at the margin of the sea. Estuarine environments are among the most productive on earth, creating more organic matter each year than comparably-sized areas of forest, grassland, or agricultural land. Many different habitat types are found in and around estuaries, including shallow open waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools, sea grass and kelp beds, and wooded swamps. The productivity and variety of estuarine habitats foster a rich abundance and diversity of wildlife. Besides serving as important habitat for wildlife, the wetlands that fringe many estuaries also perform other valuable water-filtering and purification functions. Water draining from upland areas carries sediments, nutrients, and other pollutants. As the water flows through fresh and salt marshes, much of the sediments and pollutants are effectively settled or filtered out. Wetland plants and soils also act as a natural buffer between the land and ocean, absorbing flood waters and dissipating storm surges. Salt marsh grasses and other estuarine plants also help prevent erosion and stabilize the shoreline. The protected coastal waters of estuaries also support important public infrastructure, serving as harbors and ports vital for shipping, transportation, and industry. Some attempts have been made to measure various aspects of the economic activity that depends on America’s estuaries and other coastal waters:

- [1] Estuaries provide habitat for more than 75 percent of America’s commercial fish catch, and for 80-90 percent of the recreational fish catch. Estuarine-dependent fisheries are among the most valuable within regions and across the nation, worth more than \$1.9 billion in 1990 (excluding Alaska).
- [2] Nationwide, commercial and recreational fishing, boating, tourism, and other coastal industries provide more than 28 million jobs. Commercial shipping alone employed more than 50,000 people as of January 1997.
- [3] There are 25,500 recreational facilities along the U.S. coasts - almost 44,000 square miles of outdoor public recreation areas. The average American spends 10 recreational days on the coast each year. In 1993 more than 180 million Americans visited ocean and bay beaches – nearly 70 percent of the U.S. population. Coastal recreation and tourism generate \$8 to \$12 billion annually.
- [4] In just one estuarine system – Massachusetts and Cape Cod Bays – commercial and recreational fishing generate about \$240 million per year. In that same estuary, tourism and beach-going generate \$1.5 billion per year, and shipping and marinas generate \$1.86 billion per year.

Unfortunately, population concentrations and more extensive land uses are upsetting the natural balance of estuarine ecosystems and threatening their integrity. Channels have been dredged, marshes and tidal flats filled, waters polluted, and shorelines reconstructed to accommodate human housing, transportation, and agriculture needs. Stresses caused by overuse of resources and unchecked land use practices have resulted in unsafe drinking water, beach and shellfish bed closings, harmful algal blooms, unproductive fisheries, loss of habitat, fish kills, and a host of other human health and natural resource problems. As a consequence, a number of regional (see *Chesapeake Bay Estuary Program*) and national programs (see *National Estuary Program*) have been established to preserve and protect these invaluable natural resources.

ESWTR — See *Enhanced Surface Water Treatment Rule*.

Eulittoral — (Oceanography) A subdivision of the *Littoral Zone* that refers to the sea floor environment between the high-water line and a depth of 40-60 meters (130-200 feet).

Euphotic — Of, relating to, or being the uppermost layer of a body of water that receives sufficient light for *Photosynthesis* and the growth of green plants. Also see *Euphotic Zone*.

Euphotic Zone — An area, particularly in regard to lakes, where there is sufficient light for *Photosynthesis* to take place. Contrast with *Bathyal Zone* and *Abyssal Zone*. Also see *Zone of Net Metabolic Production*.

Eurybaric — (Ecology) Describing an organism that is able to tolerate a wide range of atmospheric or hydrostatic pressure in its environment.

Eurybathic — (Ecology) (1) Capable of living in a wide range of water depths. (2) Describing an organism that lives at the bottom of a body of water.

Euryhaline — (Ecology) (1) Capable of tolerating a wide range of salt water concentrations. (2) Describing an organism that is able to tolerate a wide range of *Saline* levels in its environment.

Euryhydric — (Ecology) Describing an organism that is able to tolerate a wide range of moisture or humidity in its environment.

Eurythermic — Capable of tolerating a wide range in temperature.

Eustasy — (Oceanography) Any global fluctuation in sea level caused by changes in water supply (such as ice melting) or large-scale changes in ocean basin capacity. Thus, an eustatic condition or event.

Eutrophic — (Ecology) (1) Of a lake or other body of water containing a rich supply of plant nutrients and characterized by seasonal periods of oxygen deficiency as a result of excessive growth of algae. (2) Pertaining to a lake or other body of water containing a rich supply of plant nutrients and characterized by seasonal periods of oxygen deficiency as a result of excessive growth of algae.

Eutrophic (Water) — (1) Reservoirs and lakes which are rich in nutrients and very productive in terms of aquatic animal and plant life. (2) Pertaining to a lake or other body of water characterized by large nutrient concentrations such as nitrogen and phosphorous and resulting high productivity. Such waters are often shallow, with algal blooms and periods of oxygen deficiency. Slightly or moderately eutrophic water can be healthful and support a complex web of plant and animal life. However, such waters are generally undesirable for drinking water and other needs. Degrees of *Eutrophication* typically range from *Oligotrophic* water (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hypereutrophic* water (minimum transparency, maximum chlorophyll-a, maximum phosphorus). Also see *Carlson's Trophic State Index (TSI)* and *(Mean) Trophic State Index (TSI)*.

Eutrophic Lakes — Lakes that are rich in nutrients and organic materials, therefore, highly productive for plant growth. These lakes are often shallow and seasonally deficient in oxygen in the *Hypolimnion*. Also see *Oligotrophic Lakes*.

Eutrophic Zone — (Ecology) (1) An area, particularly with respect to lakes, where there exists sufficient light for photosynthesis to take place. (2) The upper waters of a lake or sea into which sufficient sunlight penetrates for photosynthesis and abundant plant growth to occur; extending down to about 80 meters (260 feet).

Eutrophication — (Ecology) (1) The choking of waters, particularly lakes, rivers and streams, with algae; the depletion of waters of oxygen content. Over-enrichment of a water body with nutrients resulting in excessive growth of organisms and depletion of oxygen concentration. Unhealthy increases in the growth of phytoplankton. Symptoms of eutrophication include algal blooms, reduced water clarity, periods of *Hypoxia*, and a shift toward species adapted to these conditions. (2) An aging process that takes place naturally over a long period of time in lakes. Nutrients entering the water support an increasingly dense growth of aquatic life, which depletes the oxygen supply. The body of water progresses from lake to swamp, to marsh, and may eventually become filled. The process may be greatly accelerated by excessive nutrient enrichment resulting from the activities of man. Such a process occurs naturally over geological time, but may also be accelerated by human activities, such as waste disposal, land drainage, or runoff from paved or developed surfaces, consequently leading to an increase in algae and a decrease in diversity. (3) The degradation of water quality due to enrichment by nutrients, primarily nitrogen (N) and phosphorus (P), which results in excessive plant (principally algae) growth and decay. When levels of N:P are about 7:1, algae will thrive. Low *Dissolved Oxygen (DO)* in the water is a common consequence. (4) The process of enrichment of water bodies by nutrients. The increase in the nutrient levels of a lake or other body of water; this usually causes an increase in the growth of aquatic animal and plant life. (5) Over-enrichment of a lake or other water body with nutrients, resulting in excessive growth of organisms and the depletion of oxygen. Degrees of *Eutrophication* typically range from *Oligotrophic* water (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hypereutrophic* water (minimum transparency, maximum chlorophyll-a, maximum phosphorus). Eutrophication of a lake normally contributes to its slow evolution into a *Bog* or *Marsh* and ultimately to dry land. Eutrophication may be accelerated by human activities and thereby speed up the aging process. Also see *Carlson's Trophic State Index (TSI)* and *(Mean) Trophic State Index (TSI)*.

Eutrophy — (Ecology) The state of being *Eutrophic* or undergoing *Eutrophication*.

Euxinic — (1) Describing an environment having restricted circulation and stagnant or *Anaerobic* conditions. (2) Of or relating to the material deposited in such environments and the process of its *Deposition*.

Evaporation — (1) The physical process by which a liquid (or a solid) is transformed to the gaseous state. (2) The process by which water is changed from a liquid to a vapor. (3) The transformation of liquid water to a gas or vapor. This process is accelerated by heat or wind as well as the relative humidity of the air (see *Hydrologic Cycle*). (4) The process by which water or other liquid becomes a gas (water vapor or ammonia vapor). Water from land areas, bodies of water, and all other moist surfaces is absorbed into the atmosphere as a vapor. In *Hydrology*, evaporation is vaporization that takes place at a temperature below the boiling point. Also see *Evapotranspiration*.

Evaporation, Land — Evaporation from land surfaces, in contrast to evaporation from free water surfaces.

Evaporation, Net Reservoir — The evaporative water loss from a reservoir after making allowance for precipitation on the reservoir and runoff that would have occurred from that precipitation from the land area covered by the reservoir. Net reservoir evaporation equals the total evaporation minus the precipitation on the reservoir plus the runoff from the land area covered by the reservoir.

Evaporation Opportunity (Relative Evaporation) — The ratio of the rate of evaporation from a land or water surface in contact with the atmosphere, to the Evaporativity under existing atmospheric conditions. It is the ratio of actual to potential rate of evaporation, generally expressed as a percentage. The opportunity for a given rate of evaporation to continue is determined by

the available moisture supply.

Evaporation Pan — An open tank used to contain water for measuring the amount of evaporation. The U.S. Department of Commerce Weather Bureau Class A pan is 4 feet in diameter, 10 inches deep, set up on a timber grillage so that the top rim is about 16 inches from the ground. The water level in the pan during the course of observation is maintained between 2 and 3 inches below the rim.

Evaporation Ponds — (Water Quality) Shallow ponds in which sewage sludge is placed to dry and then be removed for further treatment and/or disposal. Also, shallow ponds used to extract through evaporation various chemicals in solution or suspension, e.g., salt evaporation ponds. Also see *Evaporites*.

Evaporation Rate — The quantity of water which evaporates from a given surface per unit of time, usually expressed in inches or depth per day, month, or year.

Evaporation, Total — The sum of water lost from a given land area during any specific period of time by transpiration from vegetation and the building of plant tissue; by evaporation from water surfaces, moist soil, and snow; and by interception. It has been variously termed *Evaporation*, *Evaporation from Land Areas*, *Evapotranspiration*, *Total Loss*, *Water Loss*, and *Fly Off*.

Evaporative Cooling — Cooling of a liquid, such as water, by allowing a portion to evaporate. The process is important in the operation of cooling towers used to cool heated effluents from power plants as well as in the cooling of the human body through the evaporation of perspiration. The process is more effective than convection cooling.

Evaporativity (Potential Rate of Evaporation) — The rate of evaporation under the existing atmospheric conditions from a surface of water that is chemically pure and has the temperature of the atmosphere.

Evaporite — (Geology) A sedimentary rock whose constituent minerals were precipitated from aqueous solution as a result of evaporation.

Evaporites — Sediments deposited from an aqueous (water) solution as a result of extensive or local evaporation of a solvent, such as salts in the Great Salt Lake in the western United States.

Evapotranspiration (ET) — (1) The loss of water by evaporation from soil or vegetation. The combined processes of *Evaporation* and *Transpiration*. It can be defined as the total loss of water from a particular area, equal to the sum of the water lost by evaporation from the soil and other surfaces and that lost by transpiration from plants. (2) The natural process by which water is lost from a land area by the combination of evaporation from free surfaces and transpiration by plants. (3) The process by which plants take in water through their roots and then give it off through the leaves as a by-product of respiration; the loss of water to the atmosphere from the earth's surface by evaporation and by transpiration through plants. (4) The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces. (5) The sum of *Evaporation* and *Transpiration* from a unit land area. (6) The combined processes by which water is transferred from the earth surface to the atmosphere; evaporation of liquid or solid water plus transpiration from plants. (7) The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surface. Quantitatively, it is expressed in terms of depth of water per unit area during a specified period of time. (8) The combined evaporative-type processes, including evaporation, interception, and transpiration, usually applied to biological systems. Evapotranspiration occurs through evaporation of water from the surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants (*Phreatophytes*) whose roots tap the capillary fringe of the groundwater table. The sum of evaporation plus transpiration.

Evapotranspiration, Actual — The evapotranspiration that actually occurs under given climatic and soil-moisture conditions.

Evapotranspiration of Applied Water (ETAW) — The portion of the total *Evapotranspiration* which is provided by irrigation and landscape watering.

Evapotranspiration, Potential — (1) The maximum quantity of water capable of being evaporated from the soil and transpired from the vegetation of a specified region in a given time interval under existing climatic conditions, expressed as depth of water. (2) The water loss that will occur if at not time there is a deficiency of water in the soil for use by vegetation.

Evapotranspirometer — An instrument designed to measure *Evapotranspiration* as related to a particular place, soil type, and vegetation. The device consists of a block of soil with some planted vegetation enclosed in a container. Evapotranspiration is determined by maintaining a *Water Budget* for the container, that is, accounting for the water applied, water drained off the bottom, and the change in the moisture content of the soil. If there is a provision for drainage of the soil water, the device is referred to as a *Lysimeter*.

Even-Age Stands — Forest areas where the trees are all of the same age due to planting or harvesting the entire area at one time. Even-age stands are desirable for species whose young trees do not thrive in the shade of older trees.

Everglade — A tract of marshland, usually under water and covered in places with tall grass. Usually used in the plural.

Everglades [Florida] — The Everglades are extensive marshlands in southern Florida. They originally extended about 100 miles (160 kilometers) from Lake Okeechobee south to the Gulf of Mexico. More than 40 miles (64 kilometers) wide in some sections, they have an area of about 4,000 square miles (10,360 square kilometers). The northern part of the Everglades has been drained by a complex system of canals and dikes, and its rich soils are now used for farming. The southern part has been preserved as the 2,188 square mile (1,400,533-acre) Everglades National Park, which was established in 1947. The Everglades were formed in a flat, shallow basin with a limestone floor that slopes very gradually to the Gulf of Mexico. The area receives over 55 inches (140 centimeters) of rain annually. Water accumulates on the surface because the porous limestone floor has been sealed by peat deposits formed by decomposing vegetation. Evaporation and drainage to the Gulf of Mexico regulate the water level. The Everglades support a unique pattern of vegetation characterized by plains of saw grass and thick hummocks of pine, cypress, and mangrove trees. The mangrove may grow as high as 70–80 feet (21–24 meters). A unique ecological system, the Everglades are under threat from 100 years of dredging, draining, and land clearing. The flow of water across the area and into the Biscayne Aquifer has been drastically reduced; seawater has intruded into the aquifer; and fertilizer runoff has encouraged the growth of

algae and of non-indigenous flora. A major rescue effort has begun, involving primarily the restoration of natural water courses throughout the Everglades based on early channelization efforts of the U.S. Army Corps of Engineers (COE).

Evergreen (Plant) — (Botanical) Remaining verdant, as coniferous trees and many tropical plants. Contrasted with *Deciduous* whose leaves, fruit, or petals fall at the end of the growing period.

Evergreen Stand — A plant community where *Evergreen* trees or shrubs represent more than 50 percent of the total areal coverage of trees and shrubs. The canopy is never without foliage; however, individual trees or shrubs may shed their leaves.

Evorsion — (Geology) A process in which potholes are excavated in river beds as a result of the erosional action of vortices and eddies.

EWMP — See *Efficient Water Management Practices (EWMP)*.

Exceedence — (Water Quality) The violation of the pollutant levels permitted by environmental protection standards.

Exceedence Interval — The average number of years between the occurrence of an event of a given magnitude and one that is more extreme.

Excessive Precipitation — Standard U.S. Weather Bureau term for “rainfall in which the rate of fall is greater than certain adopted limits, chosen with regard to the normal precipitation (excluding snow) of a given place or area.” Not the same as *Excess Rainfall*.

Excess Land [USBR] — Irrigable land, other than *Exempt Land*, owned by any landowner in excess of the maximum ownership entitlement under applicable provision of reclamation law.

Excess Rainfall — Effective rainfall in excess of infiltration capacity, resulting in runoff. Not the same as *Excessive Precipitation*.

Exchange Capacity — The capacity to exchange ions as measured by the quantity of exchangeable ions in a soil.

Exempt Land [USBR] — Irrigation land in a district to which the acreage limitation and pricing provisions of reclamation law do not apply. Also see *Excess Land*.

Exempted Aquifer — Underground bodies of water defined in the *Underground Injection Control (UIC)* program as aquifers that are potential sources of drinking water though not being used as such, and thus exempted from regulations barring underground injection activities.

Exempted — (Water Quality) A state (with *Primacy*) may exempt a *Public Water System (PWS)* from a requirement involving a *Minimum Contaminant Level (MCL)*, treatment technique, or both, if the system cannot comply due to compelling economic or other factors, or because the system was in operation before the requirement or MCL was instituted, and the exemption will not create a public health risk.

Exemption [EPA] — (Water Quality) State or *U.S. Environmental Protection Agency (EPA)* permission for a water system not to meet a certain drinking water standard. An exemption allows a system additional time to obtain financial assistance or make improvements in order to come into compliance with the standard. The system must prove that: (a) there are compelling reasons (including economic factors) why it cannot meet a *Maximum Contaminant Level (MCL)* or *Treatment Technique*; (b) it was in operation on the effective date of the requirement, and (c) the exemption will not create an unreasonable risk to public health. The state must set a schedule under which the water system will comply with the standard for which it received an exemption. Also see *Exempted* and *Variance*.

Exfiltration — (Wastewater Quality) Liquid wastes and liquid carried wastes which unintentionally leak out of a sewer pipe system and into the environment.

Exhaust Trail — A condensation trail that is visible when water vapor in aircraft exhaust mixes with the air in the vehicle’s wake and saturates it. Also referred to as a *Contrail* or *Vapor Trail*.

Existing Construction [FEMA] — As used in reference to the *National Flood Insurance Program (NFIP)*, any structure already existing or on which construction or substantial improvement was started prior to the effective date of a community’s floodplain management regulations.

Exogenous — (Geology) Geologic processes originating at or near the surface of the earth or magma.

Exogenous Variable — (Statistics) A variable whose value is determined completely outside the model system and whose behavior is used to describe that of the *Endogenous Variable*. As such the terms independent or explanatory variable are frequently used. An exception to this is a *Lagged Endogenous Variable*, which may also be an explanatory variable but whose value is determined within the system of equations by past values of the explanatory variables. For example, in the equation below, for any time period t (where $t=1, 2, \dots, n$),

$$Y_t = \alpha + \beta X_t + \delta Y_{t-1} + \varepsilon_t$$

where Y_t represents the endogenous variable, X_t represents the exogenous variable, and Y_{t-1} represents the lagged endogenous variable. Also referred to as the *Independent Variable* or the *Explanatory Variable*.

Exosmosis, also Exosmotic — The passage of a fluid through a semipermeable membrane toward a solution of lower concentration, especially the passage of water through a cell membrane into the surrounding medium. Contrast with *Endosmosis (Endosmotic)*.

Exotic — (1) An organism or species that is not native to the area in which it is found. (2) A non-native or non-indigenous species, usually introduced as the result of human activities.

Exotic Species — A non-native species that is introduced into an area.

Exotic Species Load — (Biodiversity Measure) Proportion of exotic to native species, and the number and prevalence of exotic species stratified by their relative magnitude of impact on native species by impact class (i.e., low: no known negative impact on native species; moderate: known negative impact on some native species, but no known threat to distribution; high: known negative impact on some native species and known threat to distribution or reproductive success). This measure provides some information on one of the primary factors affecting biological diversity, and when compared with historical accounts can serve

as an index of past and potential future trends in biological diversity at the community/ecosystem scale.

Exotic Stream — Any stream that receives most of its water from the drainage system of another area.

Expanded Foot — A broad, bulb-shaped or fan-shaped mass of ice formed at the base of a mountain slope where a *Valley Glacier* extends onto the adjacent lowland area. Also referred to as *Piedmont Bulb*.

Expanded-Foot Glacier — A small *Glacier* consisting of an expanded foot. Also referred to as *Bulb Glacier* or *Foot Glacier*.

Exploratory Holes — An excavation drilled to obtain engineering or geological data for the purposes of defining water bearing formations for production wells.

Exponential Decay — (Statistics) A rate of decay (decline) characterized by a fixed percentage each time period, e.g., a 10 percent decline in each period of time. Represented by the equation:

$$N(t) = N_0 e^{-kt}$$

where $N(t)$ is the value of the variable at time period t , N_0 is the initial value, e is the base of the natural logarithm, k is a constant value, and t represents the various time period where $t = 1, 2, \dots, n$.

Exponential Growth — (Statistics) A rate of growth characterized by a fixed percentage each time period, e.g., a 10 percent growth each period of time. Represented by the equation:

$$N(t) = N_0 e^{kt}$$

where $N(t)$ is the population level at time t , e is the base of the natural logarithm, k is a constant value, and t represents time period where $t = 1, 2, \dots, n$. Compare to *Arithmetic Growth* and *Sigmoid Growth*.

Exposure — (1) Contact with a chemical or physical agent. (2) The amount of pollution present in a given environment that represents a potential health threat to living organisms.

Exposure Assessment — (1) The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, route, and extent (number of people) of exposure to a chemical. (2) Identifying the pathways by which toxicants may reach individuals, estimating how much of a chemical an individual is likely to be exposed to, and estimating the number likely to be exposed.

Exposure Coefficient — A term which combines information on the frequency, mode, and magnitude of contact with contaminated medium to yield a quantitative value of the amount of contaminated medium contacted per day.

Exposure Indicator — A characteristic of the environment measured to provide evidence of the occurrence or magnitude of a response indicator's exposure to a chemical or biological stress.

Exposure Level (Chemical) — The amount (concentration) of a chemical at the absorptive surfaces of an organism.

Exsiccation — See *Desiccation*.

Extended Aeration — (Water Quality) A modification of the activated sludge process which maintains a longer period of aeration, thus providing for sludge digestion within the aeration tank.

Extended Stream — A stream that is lengthened by the continuation of its course downstream across newly emerged land.

Extending Flow — A glacial flow pattern characterized by an increase in velocity with distance downstream.

Extension, Cooperative — See *Cooperative Extension*.

Externality — The unintended or unwanted byproduct of production or consumption which must be borne by society in general. A negative externality arises from the detrimental affects of use or production. For example, water pollution may represent a negative externality of motorcraft operation.

External Cost — The cost of production or consumption that must be borne by society and not specifically by the producer or consumer.

Extinction — (1) The drying up of a lake, either permanently by the destruction of its basin, or temporarily by the loss of water. Also see *Dessication*. (2) (Biology) The complete disappearance of a species because of failure to adapt to environmental change. Compare to *Extirpation*.

Extinction Depth — The minimum depth from the surface to the groundwater table at which plant species that rely on groundwater can no longer survive.

Extirpated Species — A species rendered extinct in a given area.

Extirpation — (Biology) To destroy or remove completely, as a species from an particular area, region, or habitat. Compare to *Extinction*.

Extractable Organics — (Water Quality) Organic chemical compounds that can be removed from a water sample by the solvent methylene chloride under conditions of pH greater than 11 or less than 2. Organic compounds in water represent a class of pollutants that are potentially toxic materials.

Extrapolate/Extrapolation — (Statistics) (1) Estimation of unknown values by extending or projecting from known values. (2) The continuation, by means of simple estimation or sophisticated analysis, of a trend of time series data beyond its last observed value. The function of time series model building is to add some degree of certainty and confidence to this extrapolation process by analyzing the past behavior of the data and attempting to fit a model to its historical patterns which may then be used to forecast (extrapolate) its future values. Also see *Interpolate/Interpolation*.

Extreme High Water — (Oceanography) The highest recorded level of the tide at a specified place.

Extreme High Water of Spring Tides — (Oceanography) The highest tide occurring during a lunar month, usually near the new or full moon. This is equivalent to extreme higher high water of mixed semidiurnal tides.

Extreme Low Water — (Oceanography) The lowest recorded level of the tide at a specified place.

Extreme Low Water of Spring Tides — (Oceanography) The lowest tide occurring during a lunar month, usually near the new or full moon. This is equivalent to extreme lower low water of mixed semidiurnal tides.

Extreme Value Series — Hydrological series which includes the largest or smallest values, with each value selected from an equal time interval in the record.

Extremely Hazardous Substances (EHS) [EPA] — Any of approximately 366 chemicals or hazardous substances identified by the *U.S. Environmental Protection Agency (EPA)* on the basis of hazard or toxicity and listed under *Emergency Planning and Community Right-to-Know Act (EPCRA)*. The list is periodically revised.

Extrusive Bedrock — (Geology) Those *Igneous Rocks* derived from volcanic lavas that cooled on the surface of the earth. This lava cools rapidly and forms fine-textured rocks such as basalt and andesite.

Extrusive Rocks — Igneous rocks formed from magma that flows out on the Earth's surface. These rocks cool rapidly, producing a fine crystalline structure.

Exude — (1) To ooze forth. (2) To discharge or emit a liquid gradually.

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F

F [T] (Self-purification Factor) — The self-purification factor is an indication of the ability of a stream to assimilate a waste discharge. It is defined as the ratio of the re-aeration (r) and the rate of deoxygenation (k), or $T = r/k$, where T is called the self-purification factor.

FAC — Free Available Chlorine.

Face (of a Dam) — The external surface of a structure, such as the surface of an appurtenance or a dam.

Facilities Plans — Plans and studies related to the construction of water treatment works necessary to comply with the *Clean Water Act (CWA)*. A facilities plan investigates needs and provides information on the cost effectiveness of alternatives, a recommended plan, an *Environmental Assessment (EA)* of the recommendation, and descriptions of the treatment works, costs, and a completion schedule.

Facultative Bacteria — (1) Facultative bacteria can use either molecular (dissolved) oxygen or oxygen obtained from food material such as sulfate or nitrate ions. (2) Bacteria that can live under *Aerobic* or *Anaerobic* conditions.

Facultative Phreatophyte — Plants that utilize moisture from groundwater for a portion of their water requirements.

Facultative Pond — (Wastewater Treatment) The most common type of pond in current use. The upper portion (*Supernatant*) is aerobic, while the bottom layer is *Anaerobic*. Algae supply most of the oxygen to the supernatant.

Fahrenheit (F) — (1) A unit of temperature. (2) Of or relating to a temperature scale that registers the freezing point of water as 32EF and the boiling point as 212EF at one atmosphere of pressure. See *Fahrenheit Temperature Scale*.

Fahrenheit Temperature Scale — A thermometric scale on which the freezing point of water is at 32EF (Fahrenheit) above the 0E(F) mark on the scale, and the boiling point of water is at 212EF. The Fahrenheit temperature scale was designed by German physicist Daniel Fahrenheit and is commonly used in the United States. Contrast with the *Centigrade Temperature Scale*, using degrees *Celsius* (EC), in which 0E(C) marks the freezing point of water and 100EC indicates the boiling point of water (at sea level). The formula for converting a Fahrenheit temperature to Celsius is $CE = 5/9 \times (FE - 32)$.

Failure — The collapse or slippage of a large mass of bank material into a stream.

Fair-Weather Runoff — See *Base Runoff*.

Fairfield-Hardy Digester — (Water Quality) A machine that decomposes garbage, sewage sludge, industrial and other organic wastes by a controlled continuous *Aerobic-Thermophilic Process*.

Fallon National Wildlife Refuge (NWR) [Nevada] — One of the nine *National Wildlife Refuges (NWR)* located in the State of Nevada, the Fallon NWR was established in 1931 and encompasses approximately 17,900 acres (28 square miles) where the Carson River terminates in the Carson Sink and is situated within the northwest portion of the *Stillwater Wildlife Management Area* near the town of Fallon in Churchill County, Nevada. Due to typically limited and uncertain flows of the Carson River at its terminus, generally not enough water enters this refuge to maintain it as a viable wetland area. The Fallon NWR is currently managed by the *U.S. Fish and Wildlife Service (USFWS)* along with the *Stillwater National Wildlife Refuge* and is included as part of the *Stillwater Wildlife Management Area*. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Fall Overturn — A physical phenomenon that may take place in a body of water during early autumn. The sequence of events leading to fall overturn include:

- [1] The cooling of surface waters;
- [2] A density change in surface waters producing convection currents from top to bottom;
- [3] The circulation of the total water volume by wind action; and
- [4] Eventual vertical temperature equality.

The overturn results in a uniformity of the physical and chemical properties of the entire water body. Also referred to as *Fall Turnover*. Also see *Spring Overturn*.

Falling Limb — The portion of the *Hydrograph* trace immediately following the peak and reflecting the decreasing production of storm flow.

Fallow — (1) Allowing cropland, either tilled or untilled, to lie idle during the whole or greater portion of the growing season. (2) Land plowed and tilled and left unplanted.

Falls — (1) A waterfall or other precipitous descent of water. A drop over which the water falls free at least part of the way. (2) Another name for a *Waterfall*, especially in specific place names; e.g., Niagara Falls, Victoria Falls, etc.

False Ice Foot — (Oceanography) Ice formed on a beach terrace just above the high-water line; generally caused by snow that melts further up the shore, but may also contain accretions of sea ice from spray or spring tides.

Fan — A generic term for constructional landforms that are built of more-or-less stratified alluvium and that occur on the piedmont slope, downslope from their source of alluvium.

Fan Apron — A component landform comprised of a sheet-like mantle of relatively young alluvium covering part of an older fan piedmont (and occasionally alluvial fan) surface. It somewhere buries a pedogenic soil which can be traced to the edge of the fan apron where the soil emerges as the land surface, or relict soil. No buried soils should occur within a fan-apron mantle, rather,

they separate mantles.

Fan Collar — A component landform comprised of a thin, short, relatively young mantle of alluvium along the very upper margin of a major alluvial fan at a mountain front. The mantle somewhere buries a pedogenic soil that can be traced to the edge of the fan collar where it emerges as the land surface, or relict soil.

Fan-Head Trench — A relatively deep drainageway originating in a mountain valley and cut into the apex of, and commonly across an alluvial fan. It may empty into an interfan-valley drainage, debouch onto the fan piedmont, or cross the fan piedmont.

Fan Piedmont — The most extensive major landform of most piedmont slopes, formed by the lateral coalescence of mountain-front alluvial fans downslope into one generally smooth slope without the transverse undulations of the semi-conical alluvial fans and by accretion of fan aprons. Fan piedmonts commonly are complexes of many component landforms.

Fan Remnant — A generic term for component landforms that are the remaining parts of various older fan landforms that either have been dissected (erosional fan remnants) or partially buried (non-buried fan remnants). Erosional fan remnants must have a flattish summit of relict fan surface; non-buried fan remnants are all relict fan surfaces. Fan remnants may be specifically identified as fan-piedmont remnants, inset-fan remnants, etc.

Fan-Remnant Sideslope — A landform element comprised of the relatively young erosional slope around the sides of an erosional fan remnant. It is composed of should, backslope, and footslope slope components.

Fan Skirt — A major landform comprised of laterally coalescing, small alluvial fans that issue from gullies cut into, or are extensions of inset fans of the fan piedmont and that merge along their toeslopes with the basin floor. Fan skirts are smooth or only slightly dissected and ordinarily do not comprise component landforms.

Fanglomerate — Heterogeneous materials that were originally deposited in an *Alluvial Fan* but since deposition have been cemented into solid rock.

Fanlette — A very small, normally undissected alluvial fan, something less than a few tenths of a square mile in area that may occur below a gully, inset fan, or ravine in a variety of positions on the piedmont slope or within mountain valleys.

Farm Delivery Requirement — The *Crop Irrigation Requirement* plus farm losses due to evaporation, deep percolation, surface waste, and nonproductive consumption. The losses are measured by the *Farm Irrigation Efficiency*, which is the percent of farm-delivered water that remains in the root zone and is available for crop growth.

Farm Efficiency — The consumptive *Crop Irrigation Requirement (CIR)* divided by the farm water delivery.

Farm Headgate Delivery (Diversión) — That amount of water in acre feet (AF) delivered through a farm headgate.

Farm Irrigation Efficiency — An expression comparing the amount of water actually required for growing a crop to the amount of irrigation water that is diverted at the farm headgate. Expressed as a percentage on an annual basis.

Farm Pond — A water impoundment made by constructing a dam or embankment or by excavating a pit or “dug out”.

Farm Surface Runoff (Tailwater) — A portion of the *Farm Headgate Delivery* that flows off the lower portion of the farm or field surface (drain ditch) flow. This is one loss component considered in *Farm Irrigation Efficiency*.

Farm Waste and Deep Percolation — The amount of irrigation water delivered to the crop area from a canal turnout or groundwater pump that is not consumptively used on the crop area. Includes water moving through the root zone to the water table, water intercepted by drainage systems, and surface waste to natural or constructed drainage systems, and non-cropped areas.

Farmland, Prime — As defined in the *Farmland Protection Policy Act of 1981*: Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses (urban areas are not included). It has the soil quality, growing season, and moisture supply needed for the economic production of sustained high yields of crops when treated and managed (including water management) according to acceptable farming methods. Prime farmland includes land that is being used currently to produce livestock and timber, but it excludes land committed to urban development or water storage.

Fast Ice — (1) Pack ice that is attached to the shore at the place where it originally formed. (2) A term that is loosely used to denote any sea ice attached to the shore (ice foot or ice shelf), beached (shore ice), or frozen to the bottom (anchor ice).

Fata Morgana — See *Mirage*.

Fathom — (1) A unit of length equal to 6 feet (1.83 meters), used principally in the measurement and specification of marine depths. (2) To measure the depth of a body of water as with a *Lead Line*.

Faucet — A device for regulating the flow of a liquid from a reservoir such as a pipe or drum.

Fault — (Geology) (1) A fracture or fracture zone along which the opposite sides have been relatively displaced. A fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture. (2) A fracture in rock along which movement can be demonstrated. A fracture in the earth's crust forming a boundary between rock masses that have shifted. Faults may be classified as follows:

- [1] **Active Fault** — A fault that has moved recently and which is likely to move again, usually defined as one that has shown movement within the last 11,000 years and can be expected to move again within the next 100 years;
- [2] **Potentially Active Fault** — A fault that moved within the Quaternary Period (i.e., within the last 2 million years) or a fault which, because it is judged to be capable of ground rupture or shaking, poses an unacceptable risk for a proposed project or structure;
- [3] **Historically Active Fault** — A fault active within the last 200 years;
- [4] **Inactive Fault** — A fault which has shown no evidence of movement in recent geologic time and no potential for movement in the relatively near future.

Fault Creep — A very slow movement along a fault which is unaccompanied by perceptible earthquakes.

Fault Escarpment — (Geology) A fracture or fracture zone along which there has been displacement of one side with respect to the other.

Fault-Line Scarp — A steep slope produced along an old fault line by differential weathering and erosion, rather than by fault movement.

Fault, Rupture — A break in the ground along the fault line during an earthquake.

Fault Sag Ponds — A small, enclosed depression along an active or recent fault. It is caused by differential movement between slices and blocks within the fault zone or by warping and tilting associated with differential displacement along the fault, and it forms the site of a sag pond.

Fault Scarp — A cliff formed by a fault, usually modified by erosion unless the fault is very recent.

Fault Trace — The intersection of a fault and the earth's surface as often revealed by dislocation of fences and roads and/or by ridges and furrows in the ground.

Fault Zone — A fault zone consists of numerous interlacing small faults instead of a single clean fracture.

Fauna — (1) A term used to describe the animal species of a specific region or time. (2) All animal life associated with a given habitat, country, area, or period.

Feasibility Study (FS) — (1) A complete assessment of alternative courses of action to solve one or more problems, to meet needs, and to recommend the most practical course of action consistent with state and local planning objectives. (2) (Environmental) Analysis of the practicability of a proposal, e.g., a description and analysis of potential cleanup alternatives for a site such as one on the *National Priorities List (NPL)*. The feasibility study usually recommends selection of a cost-effective alternative. It usually starts as soon as the *Remedial Investigation (RI)* is underway; together, they are commonly referred to as the "RI/FS".

Fecal Bacteria — Any type of bacteria whose normal habitat is the colon of warm-blooded mammals, such as man. These organisms are usually divided into groups, such as *Fecal Coliform* or *Fecal Streptococci (Streptococcus)*.

Fecal Coliform Bacteria — (1) Bacteria that form in the colon of humans or other warm-blooded animals and is transmitted through fecal material. The presence of fecal coliform bacteria in water, while not threatening to human health, is often used to indicate the presence of other harmful *Pathogens*. (2) A group of bacteria normally present in large numbers in the intestinal tracts of humans and other warm-blooded animals. Specifically, the group includes all of the rod-shaped bacteria that are non-sporeforming, *Gram-Negative*, lactose-fermenting in 24 hours at 44.5°C, and which can grow with or without oxygen. In the laboratory, they are defined as all organisms that produce blue colonies with specified time frames. The presence of this type of bacteria in water, beverages, or food is usually taken to indicate that the material is contaminated with solid human waste. Bacteria included in this classification represent a subgroup of the larger group termed *Coliform*. Their concentrations are expressed as number of colonies per 100 mL of sample.

Fecal Material — (Water Quality) Solid waste produced by humans and other animals and discharged from the gastrointestinal tract. Also referred to as feces or solid excrement, it is a component of domestic sewage and must be treated to avoid the transmission of fecal bacteria and other organisms or disease.

Fecal Streptococcal Bacteria — Bacteria found in the intestine of warm-blooded animals. Their presence in water is considered to verify fecal pollution. They are characterized as gram-positive, cocci bacteria that are capable of growth in brain-heart broth. In the laboratory, they are defined as all organisms that produce red or pink colonies with 48 hours at 35 degrees Celsius plus or minus 1 degree Celsius on KF-streptococcus medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 mL of sample. Also see *Fecal Streptococcus*.

Fecal Streptococcus — A group of bacteria normally present in large numbers in the intestinal tracts of warm-blooded animals other than humans. By assessing the ratio of coliforms to streptococci in a water sample, a rough estimate can be made of the relative contribution of fecal contamination from the two mentioned possible sources.

Federal Emergency Management Agency (FEMA) — An independent agency of the federal government founded in 1979 and reporting to the President of the United States and headquartered in Washington D.C. FEMA's mission is to reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. Primary support functions of FEMA include; (1) advising on building codes and flood plain management; (2) teaching people how to get through a disaster; (3) helping equip local and state emergency preparedness; (4) coordinating the federal response to a disaster; (5) making disaster assistance available to states, communities, businesses and individuals; (6) training emergency managers; (7) supporting the nation's fire service; and (8) administering the national flood and crime insurance programs (*National Flood Insurance Program*). FEMA's operating directorates consist of: (1) Mitigation Directorate; (2) Information Technology Directorate; (3) Federal Insurance Administration (Program); (4) Operations Support Directorate; (5) Preparedness Directorate; (6) Response and Recovery Directorate; (7) United States Fire Administration; and (8) ten Regional Offices. FEMA's ten regions, Federal Regional Centers, and states included in each region are:

- [1] **Region I (Boston, Massachusetts)** – Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont;
- [2] **Region II (New York, N.Y., Caribbean Division – San Juan, Puerto Rico)** – New York, New Jersey, the Commonwealth of Puerto Rico and the Territory of the U.S. Virgin Islands;
- [3] **Region III (Philadelphia, Pennsylvania)** – District of Columbia, Delaware, Maryland, Pennsylvania, Virginia, West Virginia;
- [4] **Region IV (Atlanta, Georgia)** – Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina and Tennessee;
- [5] **Region V (Chicago, Illinois)** – Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin;
- [6] **Region VI (Denton, Texas)** – Arkansas, Louisiana, New Mexico, Oklahoma and Texas;
- [7] **Region VII (Kansas City, Missouri)** – Iowa, Kansas, Missouri, Nebraska;
- [8] **Region VIII (Denver, Colorado)** – Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming;
- [9] **Region IX (San Francisco, California)** – Arizona, California, Hawaii and Nevada; and the Territory of American

Samoa, the Territory of Guam, the Commonwealth of the Northern Mariana Islands, the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau;

[10] **Region X (Bothell, Washington)** – Alaska, Idaho, Oregon and Washington.

Federal Insurance Administration (FIA) — A component of the *Federal Emergency Management Agency (FEMA)* directly responsible for administering the flood insurance aspects of the *National Flood Insurance Program (NFIP)*.

Federal Power Act — An act of Congress creating a federal licensing system administered by the *Federal Energy Regulatory Commission (FERC)* and requiring that a license be obtained for nonfederal hydroelectric projects proposing to use *Navigable* waters or federal lands. The act contains a clause modeled after a clause in the *Reclamation Act of 1902* which disclaims any intent to affect state water rights law. Subsequently, in a number of decisions dating back to the 1940s, the U.S. Supreme Court held that the provisions of both the Reclamation Act and the Federal Power Act preempted inconsistent provisions of state law. Decisions under both acts found that these clauses were merely “saving clauses” which required the United States to follow minimal state procedural laws or to pay just compensation where vested non-federal water rights are taken. Later the Supreme Court overturned a number of its earlier decisions and required that the *Bureau of Reclamation (USBR)* comply with conditions in state water rights permits unless those conditions conflict with “clear Congressional directives.” However, no such reversal of the Federal Power Act’s provisions followed and more recent decisions (*Sayles Hydro Association v. Maughan*, February 1993) reinforced this fact by holding that federal law has “occupied the field,” preventing any state regulation of federally licensed power projects other than determining proprietary water rights. This precedent has far-reaching implications over states’ rights to regulate water projects and stream flows within their borders. There have been instances where holders of Federal Power Act licenses have claimed preemption from state safety of dams requirements, minimum stream flow requirements, and state designation of wild and scenic streams. Also see *Equal Footing Doctrine (U.S. Constitution)* and *Public Trust Doctrine*.

Federal Reserved Water Rights — A category of federal water rights, created by federal law. These rights are created when the federal government withdraws land from the public domain to establish a federal reservation such as a national park, forest, or Indian reservation. By this action, the government is held to have reserved water rights sufficient for the primary purpose for which the land was withdrawn. See *Reserved Water Rights [Federal]*. Also see *Winters Rights (Decision)*, *Reservation Doctrine*, *Reserved Rights Doctrine*, and *Winters Doctrine*, and *Water Law [Federal]*.

Federal Water Pollution Control Act [Public Law 92–500] — More commonly referred to as the *Clean Water Act (CWA)*, constitutes the basic federal water pollution control statute for the United States. Originally based on the *Water Quality Act of 1965* which began setting water quality standards. The 1966 amendments to this act increased federal government funding for sewage treatment plants. Additional 1972 amendments established a goal of zero toxic discharges and “fishable” and “swimmable” surface waters. Enforceable provisions of the CWA include technology-based effluent standards for point sources of pollution, a state-run control program for nonpoint pollution sources, a construction grants program to build or upgrade municipal sewage treatment plants, a regulatory system for spills of oil and other hazardous wastes, and a wetlands preservation program.

Feeder — See *Tributary*.

Feedlot — A confined area for the controlled feeding of animals. Tends to concentrate large amounts of animal waste that cannot be absorbed by the soil and, therefore, may be carried to nearby streams or lakes by rainfall runoff.

Feedwater — (Water Quality) Water input into a desalting or water treatment plant.

Feet Per Second (ft./sec.) — A measure of the velocity of moving water.

FEMA — See *Federal Emergency Management Agency (FEMA)*.

Fen — Low land covered wholly or partly with water; a *Moor* or *Marsh*. A type of *Wetland* that accumulates peat deposits. Fens are less acidic than *Bogs*, deriving most of their water from groundwater rich in calcium and magnesium. Also see *Calcareous Fens*.

Fermentation, Anaerobic — (Water Quality) The process in which carbohydrates are converted in the absence of oxygen to hydrocarbons (such as methane gas).

Ferrous Sulfate — A greenish crystalline compound, $\text{FeSO}_4 \cdot \text{H}_2\text{O}$, used as a pigment, fertilizer, and feed additive, in sewage and water treatment, and as a medicine in the treatment of iron deficiency. Also called *Copperas*.

Fertigation — The use of irrigation water as a vehicle for spreading fertilizer on the land.

Fertilizer — (1) Any formulation or product used as a plant nutrient which is intended to promote plant growth and contains one or more plant nutrients. (2) Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth. Various types of fertilizers include acid-forming, blended, bulk-blended, chemical, coated, conditioned, granular, liquid, non-granular, prilled, solution, straight, and suspension.

Fetch — (1) The distance traveled by waves in open water, from their point of origin to the point where they break. (2) The distance the wind blows over water or another homogeneous surface without appreciable change in direction.

Fibrous Ice — See *Acicular Ice*.

Field — (1) A broad, level, open expanse of land; a meadow. (2) A cultivated expanse of land, especially one devoted to a particular crop. (3) A portion of land or a geologic formation containing a specified natural resource. (4) A wide, unbroken expanse, as of ice as an *Ice Field*.

Field Capacity — (1) The capacity of soil to hold water. It is measured by the soil scientist as the ratio of the weight of water retained by the soil to the weight of the dry soil. (2) The maximum amount of water held in a given soil against gravity after excess water has drained away. (3) The moisture content of the soil, expressed as a moisture percentage on a dry-weight basis, after excess gravitational water from a thorough wetting of the soil profile by rain or irrigation water has drained away. Also referred to as *Field-Moisture Capacity*.

Field Diversion — An interception channel near the contour to carry runoff to a waterway. Intervals vary with the precipitation,

slope, and cropping.

Field Moisture — Water that is present in the ground above the *Water Table*.

Field-Moisture Capacity — The quantity of water which can be permanently retained in the soil in opposition to the downward pull of gravity. Also see *Field Capacity*.

Field-Moisture Deficiency — The quantity of water which would be required to restore the soil moisture to *Field-Moisture Capacity*.

Field Permeability — Permeability corresponding to the temperature which occurs under field conditions.

Field Sprinkler System — A system of closed conduits carrying irrigation water under pressure to orifices designed to distribute the water over a given area.

50-Year, 24-Hour Duration Flood — The flood magnitude expected to be equaled or exceeded on the average of once in 50 years, with a two percent chance of being exceeded in any given year, determined by using the 50-year, 24-hour storm unless gauging data is available and proved to be accurate.

Filamentous Algae — Aggregations of one-celled plants that grow in long strings or mats in water and are either attached or free floating and tend to plug canals, weirs, and other structures, but also provide habitat of invertebrate animals.

Filamentous Organisms — (Wastewater Treatment) Organisms that grow in a thread or filamentous form. Common types are *Thiothrix* and *Actinomyces*. A common cause of sludge bulking in the *Activated Sludge Process*.

Fill — (Geology) Any sediment deposited by any agent such as water so as to fill or partly fill a channel, valley, sink, or other depression.

Fill Material — Soil that is placed at a specified location to bring the ground surface up to a desired elevation or angle of slope.

Fill Terrace — See *Alluvial Terrace*.

Filling — Depositing dirt, mud or other materials into aquatic areas to create more dry land, usually for agricultural or commercial development purposes, and frequently with ruinous ecological consequences. Also see *Wetland Banking*, *Wetland "Clumping"* (*Aggregation*), and *Wetland Mitigation*.

Film Water — See *Pellicular Water*.

Filter — (1) A device used to remove solids from a mixture or to separate materials. (2) A device or structure for removing solid or colloidal material, usually of a type that cannot be removed by sedimentation, from water or other liquid. (3) A porous material through which a liquid or gas is passed in order to separate the fluid from suspended particular matter. Suspended materials are frequently separated from water using filters.

Filter Bed — A layer of sand or gravel on the bottom of a reservoir or tank, used to filter water or sewage.

Filter Cake — (1) The solids or semisolids deposited on a filter as a fluid is moved through it. (2) The remaining solids or semisolids on a filter after the fluid in a material is extracted by a negative pressure.

Filter Fabric — A polypropylene textile used to keep soil separate from water. Comes in many different forms and is used for construction roads, lining ponds, and in many erosion control projects.

Filter Feeder — An aquatic animal, such as a clam, barnacle, or sponge, that feeds by filtering particulate organic material from water. Such species frequently serve as excellent *Bioindicators* for water quality conditions.

Filter Pack — Sand or gravel that is smooth, uniform, clean, well-rounded and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation material from entering the screen.

Filter Strip — A strip or area of vegetation used for removing sediment, organic matter, and other pollutants from runoff and waste water.

Filter Zone (of a Dam) — A band or zone of granular material that is incorporated into a dam and is graded (either naturally or by selection) so as to allow seepage to flow across or down the filter without causing the migration of material from zones adjacent to the filter zone.

Filterable — Of particles that are sufficiently small to allow their passage through filters capable of retaining most particles. For example, a filterable virus is one that will pass through a filter that will normally retain bacteria.

Filtrate — Liquid that has been passed through a filter.

Filtration — (1) A series of processes that physically removes particles from water. The process in which suspended matter is removed from a liquid through a medium which is permeable to the liquid but not to the suspended material. (2) (Water Quality) A treatment process, under the control of qualified operators, for removing solid (particulate) matter from water by means of porous media such as sand or a man-made filter; often used to remove particles that contain *Pathogens*. (3) The process of passing water through materials with very small holes to strain out particles. Water treatment plants use filters usually composed of gravel, sand, and anthracite carbon. These materials settle into a compact mass that forms very small holes. Particles are filtered out as treated water passes through these holes. These holes are small enough to remove microorganisms including algae, bacteria, and protozoans, but not viruses. Viruses are eliminated from drinking water through the process of disinfection using chlorine. (4) The process of separating suspended solids from their liquid by forcing the latter through a porous medium. Two types of fluid filtration occur in a borehole during the drilling process: dynamic filtration when circulating, and static filtration when at rest.

Final Clarifier — (Water Quality) A gravitational settling tank installed as part of some wastewater treatment plants and placed after the biological treatment step. The tank functions to remove suspended solids. Also referred to as *Secondary Clarifier*.

Financial Assurance — (Environmental) A financial instrument, documentation, or other means to guarantee that sufficient funds are available to ensure the performance of corrective actions to contain, mitigate, and remediate all pollution, contamination, or degradation of the environment that may result from an impact.

Finding of No Significant Impact (FONSI) — A document prepared by a federal agency showing why a proposed action would not have a significant impact on the environment and thus would not require the preparation of an *Environmental Impact*

Statement (EIS). A FONSI is based on the results of an *Environmental Assessment (EA)*.

Finger Lake — Any of a group of long, narrow lakes occupying a glacial trough or retained by a morainal dam across the lower end of a glacial valley.

Finished Water — (Water Quality) (1) Treated drinking water that meets state and federal drinking water regulations. (2) Water that has completed a purification or treatment process; water that has passed through all the processes in a water treatment plant and is ready to be delivered to consumers. This water is ready to be delivered to consumers. Also called *Product Water*. Contrast with *Raw Water*.

Finite Resource — See *Nonrenewable Resource*.

Firm Capacity — For public drinking water supplies, the system delivery capacity with the largest single water well or production unit out of service.

FIRM Map — Flood insurance rate map used to establish the insurance rates for structures under the *National Flood Insurance Program*.

Firm Yield — (1) The maximum annual supply of a given water development that is expected to be available on demand, with the understanding that lower yields will occur in accordance with a predetermined schedule or probability. (2) The dependable annual water supply that could be available in all years, without exceeding specified shortages in agricultural deliveries during droughts. Sometimes referred to as *Dependable Yield*.

Firn (Firn Snow) — (1) A loose, permeable, granular material that is over a year old, and which is transitional between snow and glacier ice. (2) Old snow on the top of glaciers that has become granular and compact through temperature changes, forming the transition stage to glacial ice. Also referred to as *Neve*.

Firn Field — Any area of *Firn*, specifically the accumulation area or upper region of a glacier, where firn is created. Also referred to as, *Firn Basin* or *Névé*.

Firn Line — (1) The highest level to which the fresh snow on a glacier's surface retreats during the melting season; the line separating the *Accumulation Area* from the *Ablation Area*. (2) The highest level to which winter snow remains on a glacier during the following summer. Also referred to as *Firn Limit*.

Firnification — The process whereby snow is converted to *Firn*, which is later transformed into glacier ice.

First Bottom — (Geology) The normal floodplain of a river or stream.

First Draw — The water that comes out when the tap is first opened, likely to contain the highest level of lead contamination from plumbing fixtures and materials.

First Draw Sample — A one-liter sample of tap water, collected in accordance with Code of Federal Regulations Section 141.86(b)(2), that has been standing in plumbing pipes at least 6 hours and is collected without flushing the tap.

“First in Time, First in Right” — A phrase indicating that older water rights have priority over more recent rights if there is not enough water to satisfy all rights. See (*Prior Appropriation Doctrine* and *Appropriative Water Rights*).

Firth — A narrow inlet or arm of the sea; an *Estuary*.

Fish — (1) (Common) Any of various cold-blooded, aquatic vertebrates having gills, commonly fins, and typically an elongated body covered with scales. The name includes basically three unrelated classes: (a) jawless fish; (b) cartilaginous fish; and (c) bony fish. (2) Any object lost in the borehole of a well.

Fish, Classifications — Fish classifications (taxonomy) provide a means to group fish types according to general characteristics of order. There exist a number of different systems for classifying fish and admittedly much debate still exists over a universally accepted classification system. Generally, however, most fish classification systems divide the world of fishes into three basic classes: (1) jawless fishes; (2) cartilaginous fishes; and (3) bony fishes. The listing below presents one particular classification system by fish *Class* (bold and italics), *Order* (italics), the various Common Names (underlined) within each order, and the number of known species within each common name (in parentheses).

- [1] ***Agnatha*** (jawless fishes)
 - Cyclostomata*
 - Lampreys (30 species)
 - Hagfishes (30 species).
- [2] ***Chondrichthyes*** (fishes with a cartilage skeleton)
 - Selachii*
 - Sharks (over 200 species)
 - Batoidei*
 - Rays, skates and stingrays (over 300 species).
- [3] ***Osteichthyes*** (fishes with a boney skeleton)
 - Dipnoi*
 - Lungfishes (6 species)
 - Acipenseriformes*
 - Sturgeons (25 species)
 - Paddlefishes (2 species)
 - Polypteriformes*
 - Bichirs or reedfishes (11 species)
 - Elopiformes*
 - Bonefishes (4 species)
 - Tarpons (2 species)
 - Ladyfish (6 species)

- Anguilliformes*
 - Eels (over 500 species)
- Clupeiformes*
 - Herrings (190 species)
 - Anchovies (200 species)
- Osteoglossiformes*
 - Bony tongues (6 species)
 - Freshwater butterfly fish (1 specie)
- Salmoniformes*
 - Salmons, trouts, chars, smelts, greylings and whitefishes (150 species)
 - Pikes and mudminnows (10 species)
- Ostariophysi*
 - Carps, minnows, barbs, suckers and loaches (3,500 species)
 - Catfishes (2,500 species)
- Characiformes*
 - Tetras, darter and piranhas (over 1,300 species)
- Paracanthopterygii*
 - Toadfishes (45 species)
 - Trout-perches (8 species)
 - Codfishes (800 species)
- Atheriniformes*
 - Flying fishes (50 species)
 - Needlefishes and garfishes (25 species)
 - Cyprinodonts (500 species)
- Gasterosteiformes*
 - Sticklebacks (11 species)
 - Tube snout (1 specie)
 - Sea horses (24 species)
- Scorpaeniformes*
 - Scorpion fishes, rockfishes and redfishes (330 species)
- Perciformes*
 - Perches (125 species)
 - Tunas (40 species)
 - Marlins (7 species)
- Pleuronectiformes*
 - Flatfishes (2 species)
 - Flounders (over 300 species)
 - Soles (over 100 species)
- Tetraodontiformes*
 - Box fishes (25 species)
 - Puffer fishes (7 species)
 - Ocean sunfishes (3 species)

(United States) Fish and Wildlife Service (USFWS) [USDI] — Part of the U.S. Department of the Interior (USDI), the early beginnings of the Fish and Wildlife Service go back to 1871 when the federal government established the Commissioner of Fisheries. In 1896, the Division of Biological Survey was established within the Department of Agriculture. In 1939, these functions were transferred to the Department of the Interior. Then in 1940, these functions were formally consolidated and redesignated as the Fish and Wildlife Service. Further reorganization came in 1956 when the Fish and Wildlife Act created the Bureau of Sport Fisheries and Wildlife. An amendment to this act in 1974 designated the Bureau as the U.S. Fish and Wildlife Service. Today the USFWS consists of a headquarters in Washington, D.C., eight regional offices, and over 700 field units and installations. Included are more than 470 National Wildlife Refuges, comprising more than 90 million acres, 57 fish and wildlife research laboratories and field units, 43 cooperative research units at universities across the country, nearly 135 national fish hatcheries and fishery assistance stations, and a nationwide network of law enforcement agents and biologists. The functions of the USFWS primarily includes the following:

- [1] Acquires, protects and manages unique ecosystems necessary to sustain fish and wildlife, such as migratory birds and endangered species;
- [2] As specified in the *Endangered Species Act (ESA)* (1973), as amended, and in conjunction with the *National Marine Fisheries Service (NMFS)*, determines critical habitat and develops recovery plans for protected endangered and threatened species of plants and animals;
- [3] Operates fish hatcheries to support research, develop new techniques and fulfill the public demand for recreational fishing;
- [4] Operates wildlife refuges to provide, restore, and manage a national network of lands and waters sufficient in size, diversity and location to meet society's needs for areas where the widest possible spectrum of benefits associated

- with wildlife and wildlands is enhanced and made available;
- [5] Conducts fundamental research on fish, wildlife and their habitats to provide better management and produce healthier and more vigorous animals; also protects fish and wildlife from dislocation or destruction of their habitats;
 - [6] Renders financial and professional assistance to states, through federal aid programs, for the enhancement and restoration of fish and wildlife resources;
 - [7] Establishes and enforces regulations for the protection of migratory birds, marine mammals, fish and other non-endangered wildlife from illegal taking, transportation or sale within the United States or from foreign countries; and
 - [8] Communicates information essential for public awareness and understanding of the importance of fish and wildlife resources, and changes reflecting environmental degradation that ultimately will affect the welfare of human beings.

Also see *National Wildlife Refuge System*, *Endangered Species Act (ESA)*, *Endangered Species*, *Threaten Species*, and *National Oceanic and Atmospheric Administration (NOAA)*.

Fish Credit Water — Generally, water reserved in upstream reservoirs for release for downstream fisheries purposes. Often provisions will be made such that other forms of water credits, e.g., *Drought Reserve Water*, will convert to fish credit water if snowpack water content or runoff is deemed sufficient by a stipulated date.

Fish Kill — (Ecology) The mass extermination of fish caused by an abrupt change in the aquatic environment, such as the absence of oxygen, disease, or the presence of water pollution.

Fish Ladder — (1) A series of small pools arranged in an ascending fashion to allow the migration of fish upstream past construction obstacles, such as dams. (2) An inclined trough which carries water from above to below a dam so that fish can easily swim upstream. There are various types, some with baffles to reduce the velocity of the water and some consisting of a series of boxes with water spilling down from one box to the next. Also see *Fishway*.

Fish Screen — A porous barrier placed across the inlet or outlet of a pond to prevent the passage of fish.

Fisheries Conservation — (Ecology) The steps taken to protect and preserve marine or aquatic life.

Fishery — (Ecology) (1) A place for harvesting or catching fish or other aquatic life. (2) The sum of activities involved in the obtaining of fish or other aquatic life.

Fishing Waters — Waters used for angling or for commercial fishing.

Fishpond — A small body of water managed for fish.

Fishway — A passageway designed to enable fish to ascend a dam, cataract, or velocity barrier. Also referred to as a *Fish Ladder*.

Fission — The act of cleaving or splitting into parts. In biology, the division of an organism into new organisms as a process of reproduction.

Fissure — A surface of a fracture or crack in a rock along which there is a distinct separation.

Five-Hundred Year Flood (500-Year Flood) — The flood that a 0.2 percent chance of being equaled or exceeded in any year. Areas subject to the 500-year flood have a moderate to low risk of flooding. Includes flood Zones B, C, and X. One- to four-unit buildings in these zones are eligible for *Preferred Risk Policies*. A 500-year flood would be deeper than a 2100-year flood and would cover a greater area.

Fix a Sample — A sample is “fixed” in the field by adding chemicals that prevent water quality indicators of interest in the sample from changing before laboratory measurements are made.

Fixed Groundwater — Water held in saturated material within pore spaces so small that it is permanently attached to the walls, or moves so slowly that it is usually not available as a source of water for pumping.

Fjord, or Fiord — A long, narrow, deep inlet of the sea between steep slopes.

Flagellates — Microorganisms that move by the action of tail-like projections.

Flap Valve — See *Check Valve*.

Flash — To fill suddenly with water.

Flashboard — A temporary barrier, relatively low in height and usually constructed of wood, placed along the crest of the spillway of a dam to allow the water surface in the reservoir to be raised above spillway level in order to increase the storage capacity. It is designed to be readily removed, lowered or carried away by high flow or floods.

Flash Flood (also Flashflood) — (1) A sudden, localized flood of relatively great volume and short duration, generally caused by a brief, heavy rainfall in a dry area. (2) A sudden flood of great volume, usually caused by a heavy rain. Also, a flood that crests in a short length of time (hours or minutes) and is often characterized by high velocity flows. It is often the result of heavy rainfall in a localized area. (3) A flood that rises and falls quite rapidly (within a few hours of the causative event), usually the result of intense rainfall over a relatively small area. Flash floods may also result from the sudden release of water impounded by ice jams or dam or levee failures.

Flash Flood Warning — A warning issued by the *National Weather Service (NWS)* when the rapid flooding of streams, creeks or urban areas is imminent or occurring. A warning implies these conditions are life threatening and immediate action is necessary for people in the warned area. The warning may result from excessive rainfall, an ice jam, a dam break or levee failure (including on a mainstem river) or a combination of these elements.

Flash Flood Watch — An advisory issued by the *National Weather Service (NWS)* when flash flooding is possible in and close to the watch area. A watch is used to provide advance notification that warnings may later be issued.

Flat — A level landform composed of *Unconsolidated Sediments* — usually mud or sand. Flats may be irregularly shaped or elongate and continuous with the shore, whereas bars are generally elongate, parallel to the shore, and separated from the shore by water.

Flatboat — A boat with a flat bottom and square ends used for transportation of bulky freight, especially used in shallow waters.

Flat-Water — Of or on a level or slow-moving watercourse.

Floater — (1) To remain suspended within or on the surface of a fluid without sinking. To cause to remain suspended without sinking or falling. (2) To put into water; launch. (3) To flood (land), as for irrigation.

Floater — A *Wetland* plant that floats on the surface of the water.

Floating Dock — (1) A structure that can be submerged to permit the entry and docking of a ship and then raised to lift the ship from the water for repairs. Also referred to as a *Floating Drydock*. (2) A dock that is supported by metal pipes on which it can move up and down with the rise and fall of the water level.

Floating Plant — A non-anchored plant that floats freely in the water or on the surface; e.g., water hyacinth (*Eichhornia crassipes*) or common duckweed (*Lemna minor*).

Floating-Leaved Plant — A rooted, *Herbaceous Hydrophyte* with some leaves floating on the water surface; e.g., white water lily (*Nymphaea odorata*), floating-leaved pondweed (*Potamogeton natans*). Plants such as yellow water lily (*Nuphar luteum*), which sometimes have leaves raised above the surface, are considered floating-leaved plants or emergents, depending on their growth habit at a particular site.

Floc — (1) Generally, a very fine, fluffy mass formed by the aggregation of fine suspended particles, as in a precipitate. (2) In terms of water quality, clumped solids or precipitates formed in sewage by biological or chemical activity. (3) Clumps of bacteria and particulate impurities that have come together and formed a cluster. Found in flocculation tanks and settling or sedimentation basins.

Flocculate — To aggregate or clump together individual, tiny particles into small clumps or clusters.

Flocculation — (Water Quality) (1) The gathering together of fine particles in water by gentle mixing after the addition of *Coagulant* chemicals to form larger particles. (2) A chemical process involving addition of a coagulant to assist in the removal of *Turbidity* in water. (3) The agglomeration of finely divided suspended solids into larger, usually gelatinous, particles; the development of a “floc” after treatment with a coagulant by gentle stirring or mixing. (4) In water and wastewater treatment, the agglomeration or clustering of colloidal and finely divided suspended matter after coagulation by gentle stirring by either mechanical or hydraulic means such that they can be separated from water or sewage.

Floe — (1) An ice flow. Also a segment that has separated from such an ice mass. (2) (Oceanography) A piece of floating sea ice of indeterminate size, other than the floating edge of an ice shelf or glacier.

Floe Ice — Ice usually several feet thick, which has formed on the surface of a body of water and then has broken into pieces and is floating on the water’s surface.

Floeberg (or Floe Berg) — (Oceanography) A large mass of thick, heavily hummocked ice, formed by the piling up of many floes to heights as high as 15 meters (50 feet).

(The) Flood — (Biblical) The universal deluge recorded in the Old Testament as having occurred during the life of Noah.

Flood — (1) The rising of a body of water so that it overflows its natural or artificial boundaries and covers adjoining land that is not usually underwater. Thus, flood flow. (2) (Oceanography) The stage of maximum height of a tide. (3) (Agronomy) To run water on a field to the depth of a few inches to irrigate crops.

Flood, or Flood Waters — (1) Temporary inundation of normally dry land areas from the overflow of inland or tidal waters, or from the unusual and rapid accumulation or runoff of surface waters from any source. The rise in water may be caused by excessive rainfall, snowmelt, natural stream blockages, wind storms over a lake or any combination of such conditions. (2) An overflow of water onto lands that are used or usable by man and not normally covered by water. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean. (3) As defined, in part, in the *Standard Flood Insurance Policy (SFIP)*: “A general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters or from the unusual and rapid accumulation or runoff of surface waters from any source.” (4) As defined under the *National Flood Insurance Program (NFIP)*, a partial or complete inundation of normally dry land areas from (a) the overland flow of a lake, river, stream, ditch, etc.; (b) the unusual and rapid accumulation or runoff of surface waters; and (c) mudflows or the sudden collapse of shoreline land.

Flood [FEMA] — A general and temporary condition of partial or complete inundation or normally dry land areas from: (1) overflow of inland or tidal waters; (2) the unusual and rapid accumulation or runoff of surface waters from any source; (3) mudslides (i.e., mudflows) which are proximately caused by flood, as defined above, and are akin to a river of liquid and flowing mud on the surface of normally dry land areas, as when earth is carried by a current of water and deposited along the path of the current; and (4) the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding the cyclical levels which result in flood, as defined above.

Flood, 100-Year — A 100-year flood does not refer to a flood that occurs once every 100 years, but to a flood level with a 1 percent or greater chance of being equaled or exceeded in any given year. Areas below the 100-year flood level are termed *Special Flood Hazard Areas*. Areas between the 100-year and the 500-year flood boundaries are termed *Moderate Flood Hazard Areas*. The remaining areas are above the 500-year flood level and are termed *Minimal Flood Hazard Areas*.

Flood, Annual — The highest peak discharge in a water year.

Flood Abatement — See *Flood Control*.

Flood-Base Discharge — A value of high flow usually computed during the first 5 years of station operation that, on the average, is exceeded about three times per year.

Flood Boundary and Floodway Map (FBFM) — Official map of a community on which the Federal Emergency Management Agency (FEMA) or Federal Insurance Administration (FIA) have delineated the boundaries of the flood, mudslide and related erosion areas having special hazards have been designated as *Flood Zones A, M, and E*. Now superseded by the *Floodway Hazard Boundary Map (FHBH)*.

Flood Capacity — The flow carried by a stream or floodway at bankfull water level. Also, the storage capacity of the flood pool at a reservoir.

Flood Control (Storage) — The control of flood waters by the construction of flood storage reservoirs, flood water retaining structures, channel improvements, levees, bypass channels, other engineering works, or vegetative changes.

Flood Control Districts — A district organized to manage flooding hazards through land use controls and construction and maintenance of flood control structures.

Flood Control Pool — (1) Reservoir volume reserved for flood runoff and then evacuated as soon as possible to keep that volume in readiness for the next flood. (2) Reservoir volume above the active conservation and joint-use pool that is reserved for flood runoff and then released as soon as possible to keep that space available for the next flood.

Flood Control Storage — Storage above the active storage and joint-use storage that is reserved for flood releases.

Flood Crest — The maximum stage or elevation reached or expected to be reached by the waters of a flood at a given location.

Flood Damage — The direct and indirect economic loss caused by floods including damage by inundation, erosion, or sediment deposition. Indirect damages may also include emergency costs and business or financial losses. Evaluation may be based on the cost of replacing, repairing, or rehabilitating; or the comparative change in market or sales value; or on the change in income or production caused by flooding.

Flood Depth — Height of flood waters above the surface of the ground at a given point.

Flood Duration — (1) The length of time a stream is above flood stage or overflowing its banks. (2) The amount of time between the initial rise of flood, including freeboard, waters and their recession.

Flood Duration Curve — A cumulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded.

Flood Elevation — The height of flood waters above an *Elevation Datum Plane*.

Flood Fighting — Actions taken immediately before or during a flood to protect human life and to reduce flood damages such as evacuation, emergency sandbagging and diking, and provision of assistance to flood victims.

Flood Forecasting — The process of predicting the occurrence, magnitude and duration of an imminent flood through meteorological and hydrological observations and analysis. Flood forecasts are primarily the responsibility of the National Weather Service, *National Oceanic and Atmospheric Administration (NOAA)*, and are used to predict flood stages and times and indicate areas subject to flooding.

Flood Frequency — (1) Probability, expressed as a percentage, that a flood of a given size will be equaled or exceeded in any given year. (2) A statistical expression or measure of the average time period between floods equaling or exceeding a given magnitude. For example, a 100-year flood has a magnitude expected to be equaled or exceeded on the average of once every hundred years; such a flood has a one-percent chance of being equaled or exceeded in any given year. Similarly, the floods that have a 2-percent probability (1 in 50) and a 0.2-percent probability (1 in 500) of being equaled or exceeded in any year are referred to as the 50-year flood and the 500-year flood, respectively. The term is oftentimes used interchangeably with *Recurrence Interval*. Also see *Hundred-Year Flood*, *One-Percent Duration Flood*, *X-Year Flood*, and *X-Year Flood, Y-Duration Rain*.

Flood Frequency Curve — (1) A graph showing the average interval of time within which a flood of a given magnitude will be equaled or exceeded once. (2) A similar graph but plotted with the *Recurrence Intervals* of floods plotted instead.

Flood Fringe — The portion of the 100-year floodplain outside of the floodway but still subject to flooding. Sometimes referred to as *Floodway Fringe*. See *Pondage Land*.

Floodgate — (1) A gate used to control the flow of a body of water. Also referred to as a *Water Gate*. (2) Something that restrains a flood or an outpouring.

Flood Hazard Boundary Map (FHBM) — An official map of a community, issued or approved by the *Federal Emergency Management Agency (FEMA)* or Federal Insurance Administration (FIA), on which the boundaries of the floodplain and special flood hazard areas have been designated. This map is prepared according to the best flood data available at the time of its preparation, and is superseded by the *Flood Insurance Rate Map (FIRM)* after more detailed studies have been completed.

Flood Hazard Zones (Defined) — Zones on the *Flood Insurance Rate Map (FIRM)* in which the risk premium insurance rates have been established by a *Flood Insurance Study (FIS)*. The following flood hazard zone designations apply:

- [1] **Flood Zone V** – Areas along coasts subject to inundation by the 100-year flood event with additional hazards associated with storm-induced waves. Mandatory flood insurance purchase requirements apply;
- [2] **Flood Zones EV and V1-V30** – Areas along coasts subject to inundation by the 100-year flood event with additional hazards due to storm-induced velocity wave action. Mandatory flood insurance purchase requirements apply. (Zone VE is used on new and revised flood maps in place of Zones V1-V30.);
- [3] **Flood Zone A** – Areas subject to inundation by the 100-year flood event. Mandatory flood insurance purchase requirements apply;
- [4] **Flood Zones AE and A1-30** – Areas subject to inundation by the 100-year flood event determined by detailed methods. Mandatory flood insurance purchase requirements apply. (Zone AE is used on new and revised maps in place of Zones A1-A30.);
- [5] **Flood Zone AH** – Areas subject to inundation by 100-year shallow flooding (usually areas of ponding) where average depths are between one and three feet. Mandatory flood insurance purchase requirements apply;
- [6] **Flood Zone AO** – Areas subject to inundation by 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Mandatory flood insurance purchase requirements apply;
- [7] **Flood Zone A99** – Areas subject to inundation by the 100-year flood event, but which will ultimately be protected upon completion of an under construction Federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protective system, such as dikes, dams, and levees, to consider it complete for insurance rating purposes. Zone A99 may only be used when the flood protection system has reached specified statutory progress toward completion. Mandatory flood insurance purchase requirements

apply;

- [8] **Flood Zones B, C and X**— Areas identified in the community FIS as areas of moderate or minimal hazard from the principal source of flood in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Local stormwater drainage systems are not normally considered in the community's FIS. The failure of a local drainage system creates areas of high flood risk within these rate zones. Flood insurance is available in participating communities but is not required by regulation in these zones. (Zone X is used on new and revised maps in place of Zones B and C.); and
- [9] **Flood Zone D**— Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

Flooding— Temporary inundation of all or part of the floodplain along a well-defined channel or temporary localized inundation occurring when surface water runoff moves via surface flow, swales, channels, and sewers toward well-defined channels. Flooding is not necessarily synonymous with *Flooding Problem*.

Flooding Problem— The disruption to community affairs, damage to property and facilities, and the danger to human life and health that occurs when land use is incompatible with the hydrologic-hydraulic system.

Flood Insurance— A means of spreading the cost of flood losses. It enables property owners in communities participating in the *National Flood Insurance Program (NFIP)* to purchase insurance against loss resulting from floods.

Flood Insurance Rate Map (FIRM)— Official map on which the *Federal Emergency Management Agency (FEMA)* or Federal Insurance Administration (FIA) has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.

Flood Insurance Rate Zone— A zone identified on a *Flood Insurance Rate Map (FIRM)* as subject to a specified degree of flood, mudslide (i.e., mudflow) or flood-related erosion hazards, to which a particular set of actuarial rates and floodplain management requirements apply.

Flood Insurance Study (FIS)— (1) A study, funded by the *Federal Emergency Management Agency (FEMA)* or Federal Insurance Administration (FIA), and carried out by any of a variety of agencies and consultants, to delineate the special flood hazard areas, base flood elevations, and *National Flood Insurance Program (NFIP)* actuarial insurance rate zones. The study is based on detailed site surveys and analysis of site-specific hydrologic characteristics and includes flood profiles, the *Flood Insurance Rate Map (FIRM)*, the *Flood Boundary and Floodway Map (FBFM)*, and the water surface elevation of the base flood. (2) A document containing the results of an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations, mudslides and erosion hazards.

Flood, Intermediate Regional— A flood having a one percent probability, or an average frequency of occurrence on the order of once in 100 years, although the flood may occur in any year. The intermediate regional flood is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed."

Flood Irrigation— The application of irrigation water where the entire surface of the soil is covered by a sheet of water, called *Controlled Flooding* when water is impounded or the flow directed by border dikes, ridges, or ditches.

Flood, Maximum Probable— The greatest flood that may be expected at a place, taking into account all pertinent factors of location, meteorology, hydrology, and terrain.

Flood Mitigation Assistance Program (FMA)— A grant program funded by the *Federal Emergency Management Agency (FEMA)* with the objective of providing funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes and other structures insurable under the *National Flood Insurance Program (NFIP)*.

Flood of Record— The highest observed river stage or discharge at a given site during the period of record keeping. May not necessarily be the highest known stage.

Flood Peak— The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest, i.e., the maximum stage or elevation reached by the flood flow.

Flood Plain (also Floodplain)— (1) That portion of a river valley, adjacent to the river channel, which is built of sediments deposited by the river and which is covered with water when the river overflows its banks at flood stages. The flat or nearly flat land on the floor of a stream valley or tidal area that is covered by water during floods. Also, an area below the dam that has been or may be covered with water from natural runoff or from any failure of the dam. (2) The surface or strip of relatively smooth land adjacent to a river channel constructed by the present river and covered with water when the river overflows its banks. It is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. (3) (FEMA) Any normally dry land area that is susceptible to being inundated by water from any natural source. This area is usually low land adjacent to a river, stream, watercourse, ocean or lake. (4) A strip of relatively smooth land bordering a stream, built of sediment carried by the stream and dropped in the slack water beyond the influence of the swiftest current. It is called a *Living Flood Plain* if it is overflowed in times of high water but a *Fossil Flood Plain* if it is beyond the reach of the highest flood. (5) The lowland that borders a stream or river, usually dry but subject to flooding. (6) The transversely level floor of the axial-stream drainageway of a semi-bolson or of a major desert stream valley that is occasionally or regularly alluviated by the stream overflowing its channel during flood. (7) The land adjacent to a channel at the elevation of the bankfull discharge, which is inundated on the average of about 2 out of 3 years. The floor of stream valleys, which can be inundated by small to very large floods. The one-in-100-year floodplain has a probability of 0.01 chance per year of being covered with water. (8) That land outside of a stream channel described by the perimeter of the *Maximum Probable Flood*. Also referred to as a *Flood-Prone Area*.

Floodplain Fringe— The portion of the flood plain outside the floodway which is covered by floodwaters during the 100-year

recurrence interval flood. It is generally associated with shallow, standing or slowly moving water rather than deep, rapidly flowing water.

Floodplain Information Reports — Reports prepared to provide local governmental agencies with basic technical data to assist in planning for wise use and development of their flood plains.

Floodplain Management — (1) (FEMA) The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to flood control projects, floodplain land use regulations, floodproofing of buildings, and emergency preparedness plans. (2) Comprehensive flood damage prevention programs which require the integration of all alternative measures (structural and nonstructural) in investigation of flood problems and planning for wise use of the floodplain. Includes corrective and preventive measures for reducing flood damage and preserving and enhancing, where possible, natural resources in the floodplain, including but not limited to emergency preparedness plans, flood control works and floodplain management regulations and ordinances, and open space plans.

Floodplain Management Measures — Refers to an overall community program of corrective and preventive measures for reducing future flood damage. The measures take a variety of forms and generally include zoning, subdivision, or building requirements and special-purpose floodplain ordinances. Also see *National Flood Insurance Program (NFIP)* and *Federal Emergency Management Agency (FEMA)*.

Floodplain Management Regulations — Any federal, state, or local government regulations and zoning ordinances, subdivision regulations, building codes, health regulations, special purpose ordinances (such as a grading permit and erosion control requirement) and other applications of regulatory power which control development in flood-prone areas specifically for the purpose of preventing and reducing flood loss and damage.

Floodplain of Aggradation — A flood plain formed by the building up of the valley floor by sedimentation.

Floodplain Playa — A component landform consisting of very low gradient, broad, barren, axial-stream channel segments in an inter-montane basin. It floods broadly and shallowly and is veneered with barren fine textured sediments that crusts. Commonly, a floodplain playa is segmented by transverse, narrow bands of vegetation, and it may alternate with ordinary, narrow or braided channel segments.

Floodplain Regulations — (FEMA) General term applied to the full range of codes, ordinances and other regulations relating to the use of land and construction within floodplain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws and open area (space) regulations.

Flood Plane — The position or elevation occupied by the water surface of a stream during a particular flood. Also, loosely, the elevation of the water surface at various points along the stream during a particular flood. More commonly spelled *Floodplain*.

Flood Prevention — Methods or structural measures used to prevent floods.

Flood Probability — The statistical probability that a flood of a given size will be equaled or exceeded in a given period of time.

Flood Profile [FEMA] — A graph showing the relationship of water surface elevation to a specific location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Proofing (Floodproofing) — (1) Any combination of structural and nonstructural additions, changes, or adjustments to structures and properties subject to flooding primarily for the reduction or elimination of flood damage to real estate or improved property, water and sanitary facilities, structures and their contents. (2) Structural or nonstructural changes or adjustments included in the design, construction, or alternation of a building that reduce damage to the building and its contents from flooding and erosion. See *Dry Floodproofing* and *Wet Floodproofing*.

Flood Protection Elevation (FPE) — Elevation of the highest flood, including freeboard, that a retrofitting method is intended to protect against.

Flood-Related Erosion — The collapse or subsidence of land along the shore of a lake or other body of water as a result of undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding.

Flood-Related Erosion Area — A land area adjoining the shore of a lake or other body of water, which due to the composition of the shoreline or bank and high water levels or wind-driven currents, is likely to suffer flood-related erosion damage. Also referred to as the *Flood-Related Erosion Prone Area*.

Flood-Related Erosion Area Management — The operation of an overall program of corrective and preventive measures for reducing flood-related erosion damage, including but not limited to emergency preparedness plans, flood-related erosion control works, and floodplain management regulations.

Flood Routing — (1) The determination of the progressive time and shape of a flood wave at successive points along a river. (2) The process of determining progressively the timing and magnitude of a flood wave at successive points along a river. The prediction of the timing and magnitude of a flood wave in a reach of interest is usually based on a flood-routing model. Also, the determination of the attenuating effect of storage on a flood passing through a valley, channel, or reservoir. The principal types of flood-wave movement are classified as:

- [1] **Uniformly-Progressive** — The downstream movement of a flood wave that does not change in shape; such movement occurs under ideal conditions in a prismatic channel in which the variation in resistance along the channel is small; and
- [2] **Reservoir Action** — The transformation of a flood wave caused by reservoir pondage which results when the channel is irregular and the variation in resistance along the channel is large.

Both types of flood-wave movement can occur at different times in the same reach; the type that will occur apparently is

dependent largely on the *River Form*.

Flood Stage — (1) An elevation for the water level at high flows. (2) The elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured. (3) The elevation at which a stream overflows its banks and begins to cause damage along any part of its reach.

Flood Stage Profile — A graph of flooding condition water surface elevation versus distance along a river or stream. The profile may correspond to an historic flood event or an event or a specified recurrence interval. The channel bottom, as well as bridges, culverts, and dams, are usually shown on the flood stage profile.

Flood, Standard Project (SPF) — A hypothetical flood that might result from the most severe combination of meteorological and hydrological conditions that are reasonably characteristic of the geographical region involved. The SPF is the usual basis for design of flood control structures.

Flood Tide (also Floodtide) — The incoming or rising tide; the period between low water and the succeeding high water.

Floodwall — Flood barrier constructed of manmade materials, such as concrete or masonry.

Flood Warning — (1) The issuance and dissemination of information about an imminent or current flood. (2) A warning issued by the *National Weather Service (NWS)* when the height of water on streams is or is forecast to reach at or above flood stage, but in a period of time too long to be considered a *Flash Flood Warning*. A warning implies these conditions are life threatening and action is necessary for people in the warned area. See also *River Flood Warning*.

Floodwater — The water of a flood. Often used in the plural (Floodwaters).

Floodwater Detention Capacity — That part of the gross reservoir capacity which, at the time under consideration, is reserved for the temporary storage of floodwaters. It can vary from zero to the entire capacity (exclusive of dead storage) according to a predetermined schedule based upon such parameters as antecedent precipitation, reservoir inflow, potential snowmelt, or downstream channel capacities. Also referred to as *Flood-Control Capacity*.

Floodwater Retarding Structure — A structure providing for temporary storage of floodwater and for its controlled releases.

Floodwater Retention — The capacity of *Wetland* sediments and vegetation to hold excess pulses of water for subsequent discharge.

Flood Wave — A distinct rise in stage, culminating in a crest and followed by recession to lower stages.

Floodway — (1) The channel of a river or other watercourse and the adjacent land area that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. (2) A regulatory *Floodplain* under the *National Flood Insurance Program (NFIP)* that includes the channel and that portion of the adjacent floodplain that is required to pass flood flows (normally the one-in-100-year flood) without increasing the water surface elevation more than a designated height (1 foot in most areas). (3) Portion of the regulatory floodplain that must be kept free of development so that flood elevations will not increase beyond a set limit – a maximum of 1 foot under NFIP. The floodway usually consists of the stream channel and land along its sides. (4) The area regulated by federal, state, or local regulations, zoning ordinances, and building codes to provide for the discharge of the base flood so that the cumulative increase in water surface elevation is no more than a designated amount (not to exceed one foot as set by NFIP) within the 100-year floodplain. Also referred to as *Regulatory Floodway*.

Floodway Encroachment Lines — The lines marking the limits of *Floodways* on federal, state, and local floodplain maps.

Floodway Fringe — The area of the floodplain on either side of the *Regulatory Floodway* where encroachment may be permitted.

Floodway Hazard Boundary Map — See *Flood Hazard Boundary Map (FHBM)*.

Flood Zone — (1) The land bordering a stream which is subject to floods of about equal frequency; for example, a strip of the floodplain subject to flooding more often than once, but not as frequently as twice in a century (*100-Year Flood*). (2) (FEMA) Zones that begin with the letters V and A are in the *Special Flood Hazard Area (SFHA)*. Zones B, C, D, or X are within the floodplain but not in the SFHA and, therefore, are not considered to be areas requiring flood insurance for structures located in those areas.

Flooded Stream — See *Drowned Stream*

Floor — A generic term for the nearly level, lower-part of an inter-montane basin (a bolson or semi-bolson) or a major desert stream valley.

Flora — (1) A term used to describe the entire plant species of a specified region or time. The plants of a particular region or period, listed by species and considered as a whole. (2) The sum total of the kinds of plants in an area at one time. All plant life associated with a given habitat, country, area, or period. *Bacteria* are considered flora.

Floriston Rates [California and Nevada] — Currently represents the primary operational criteria of the Truckee River between its source (Lake Tahoe) and its terminus (Pyramid Lake). The rates originated in a 1915 decree (*Truckee River General Electric Decree*) in which the *U.S. Bureau of Reclamation (USBR)* gained an easement to operate the Lake Tahoe outlet dam in return for providing year-round flow rates for run-of-the-river users – hydropower and a pulp and paper mill. Along with the *Orr Ditch Decree* (1944) and the *Truckee River Agreement* (1935), which has been incorporated into the Orr Ditch Decree, these requirements govern the Truckee River flows. The Floriston rates essentially constitute a minimum instream flow in the river, as long as water is physically available in Lake Tahoe and Boca Reservoir to support the rates. Water may only be stored in Lake Tahoe and Boca Reservoir when rates are being met. The precise definition contained in the Truckee River Agreement is as follows:

- [1] **Floriston Rates** means the rate of flow in the Truckee River at the head of the diversion penstock at Floriston, California (to be measured at the Iceland gage, but currently measured at the Farad gage) consisting of an average flow of 500 cubic feet of water per second each day during the period commencing March 1 and ending September 30 of any year, and an average flow of 400 cubic feet per second each day during the period commencing October 1 and ending the last day of the next following February of any year.

- [2] **Reduced Floriston Rates** means rates of flow in the Truckee River, measured at the Iceland gage (currently the

Farad gage), effective and in force during the period commencing November 1 and ending the next following March 31 of each year, determined as follows:

- (a) 350 cubic feet per second whenever the elevation of the water surface of Lake Tahoe is below 6226.0 feet above sea level and not below 6225.25 feet above sea level; and
- (b) 300 cubic feet per second whenever the water surface elevation of Lake Tahoe is below 6225.25 feet above sea level.

Also see *Truckee River Agreement [Nevada and California]*.

Flotage — See *Flotation*.

Flotation, also Floatation — (1) The act, process, or condition of floating, also called *Flotage*. (2) The process of separating different materials, especially minerals, by agitating a pulverized mixture of the materials with water, oil, and chemicals. Differential wetting of the suspended particles causes unwetted particles to be carried by air bubbles to the surface for collection.

Flow — (1) The movement of water. (2) The rate of water discharged from a source given in volume with respect to time.

Flow Augmentation — The addition of water to a stream especially to meet instream flow needs.

Flow Boundaries — Anything which inhibits groundwater flow, such as a groundwater divide or an impermeable geologic unit.

Flow Bog — (Ecology) A *Peat Bog* whose surface level fluctuates according to the flow of the tides or of rainwater.

Flow Duration Curve — A cumulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded.

Flow Duration Percentiles — Values on a scale of 100 that indicate the percentage of time for which a flow is not exceeded. For example, the 90th percentile of river flow is greater than or equal to 90 percent of all recorded flow rates.

Flow Interval — The shortest period of time in days (typically) during which one-half (the *Half-Flow Interval*) or one-quarter (the *Quarter-Flow Interval*) of the annual runoff occurs.

Flow, Laminar — Flow of water in well-defined flow lines in which the viscous force is predominant; in channels it occurs at a *Reynolds Number* smaller than 500–2,000 and through porous media at *Reynolds Number* smaller than 1–10.

Flow Line — (1) A contour line around a body of water, indicating the water level. (2) A line in an open channel, representing the free water surface.

Flow Lines, also Flowlines (Streamline) — (1) The general path that a particle of water follows under laminar flow conditions. (2) The line indicating the direction followed by groundwater toward points of discharge. Flow lines are perpendicular to *Equipotential Lines*.

Flow Meter — A device which allows for measurement of stream flow by measuring velocity in a given cross-sectional area.

(Groundwater) Flow Model — (1) A digital computer model that calculates a hydraulic head field for the modeling domain using numerical methods to arrive at an approximate solution to the differential equation of ground-water flow. (2) Any representation, typically using plastic or glass cross-sectional viewing boxes, with representative soil samples, depicting ground-water flows and frequently used for educational purposes.

Flow, Modified — That streamflow which would have existed had the works of man in or on the stream channels and in the drainage basin been consistent throughout the period of record. Usually used with an adjective such as “present” or specific year to mean that the flow record was modified to represent the record that would have been obtained had the “present” conditions prevailed throughout the period of record. Modified flow is equal to *Virgin Flow* minus the amount of *Streamflow Depletion* occurring at the specified time.

Flow, Natural — The rate of water movement past a specified point on a natural stream from a drainage area which has not been affected by stream diversion, storage, import, export, return flow or change in consumptive use resulting from man’s modification of land use. Natural flow rarely occurs in a developed country.

Flow, Net — A graphical representation of flow lines and *Equipotential Lines* for two-dimensional, steady-state ground-water flow.

Flow, Overland — The flow of rainwater or snowmelt over the land surface toward stream channels. Upon entering a stream, it becomes runoff.

Flow Path — The subsurface course a water molecule or solute would follow in a given ground-water velocity field.

Flow Rate — (1) The speed or rate at which water is taken from a water course or the speed at which it flows past a point, usually measured in gallons per hour or cubic feet per second (cfs). (2) The rate, expressed in gallons or liters-per-hour, at which a fluid escapes from a hole or fissure in a tank. Such measurements are also made of liquid waste, effluent, and surface water movement.

Flow Regime — A range of surface runoffs having similar bed forms, resistance to flow, and means of transporting sediment.

Flow Resources versus Stock Resources — Flow resources are resources that are not permanently expendable under usual circumstances; they are resources which are replaced. They are commonly expressed in annual rates at which they are regenerated. Examples are fresh-water runoff and timber. Stock resources can be permanently expended and whose quantity is usually expressed in absolute amounts rather than in rates. Examples are coal and petroleum deposits.

Flow, Steady — A flow in which the magnitude and direction of the specific discharge are constant in time.

Flow, Turbulent — A flow in which successive flow particles follow independent path lines, and head loss varies approximately with the square of the velocity. In stream channels it occurs at a *Reynolds Number* greater than 5,000.

Flow, Uniform — A characteristic of a flow system where specific discharge has the same magnitude and direction at any point.

Flow Velocity — (1) The volume of water flowing through a unit cross-sectional area of an aquifer. Also referred to as *Specific Discharge*. (2) Speed at which water moves during a flood. Velocities usually vary across the floodplain. They are usually greatest near the channel and lowest near the edges of the floodplain.

Flow, Virgin — That streamflow which would exist had man not modified conditions on or along the stream or in the drainage basin.

Flowage — (1) The act of flowing or overflowing. (2) The state of being flooded; a body of water, such as a lake or reservoir, formed by usually deliberate flooding. (3) An outflow or overflow.

Flowage Lakes — Areas of a river system which are sufficiently deep, slow moving and wide to have lacustrine characteristics. Unlike reservoirs, they typically have wide inflow and outflow regions.

Flowing Well — An *Artesian Well* having sufficient head to discharge water above the land surface; a well where the *Piezometric Surface* lies above the ground surface.

Flowmeter — A gauge indicating the velocity of wastewater moving through a treatment plant or of any liquid moving through various industrial processes.

Flowstone — A layered deposit of calcium carbonate, CaCO_3 , on rock where water has flowed or dripped, as on the walls of a cave. Also see *Tufa*.

Flue Gas Scrubber — A type of equipment that removes fly ash and other objectionable materials from flue gas by the use of sprays, wet baffles, or other means that require water as the primary separation mechanism. Also referred to as *Flue Gas Washer*.

Fluid — Having particles which easily move and change their relative position without a separation of the mass, and which easily yield to pressure; capable of flowing; liquid or gaseous.

Fluid Ounce — (Abbreviated fl oz, fl. oz.) (1) A unit of volume or capacity in the U.S. Customary System, used in liquid measure, equal to 29.57 milliliters (1.804 cubic inches). (2) A unit of volume or capacity in the British Imperial System, used in liquid and dry measure, equal to 28.41 milliliters (1.734 cubic inches).

Fluid Potential — The mechanical energy per unit mass of a fluid at any given point in space and time with respect to an arbitrary state and datum. Loss of fluid potential results as the fluid moves from a region of high potential to one of low potential and represents the loss of mechanical energy which is converted to heat by friction.

Fluidized — A mass of solid particles that is made to flow like a liquid by injection of water or gas is said to have been fluidized. In water treatment, a bed of filter media is fluidized by backwashing water through the filter.

Flume — (1) A narrow gorge, usually with a stream flowing through it. (2) An open artificial channel or chute carrying a stream of water, as for furnishing power, conveying logs, or as a measuring device.

Fluoridate (Fluoridation) — (1) The addition of a chemical to increase the concentration of fluoride ions in drinking water to a predetermined optimum limit to reduce the incidence (number) of dental cavities (tooth decay) in children. *Defluoridation* is the removal of excess fluoride in drinking water to prevent the mottling (brown stains) of teeth. (2) To add a fluorine compound to a drinking water supply, for example, for the purpose of reducing tooth decay, particularly in children. Since 1962, the U.S. Public Health Service (PHS) has recommended an “optimal” fluoride concentration of 0.7 to 1.2 mg/l (milligrams per liter) to prevent dental caries and minimize mottling (fluorosis). In 1986, the U.S. *Environmental Protection Agency (EPA)* set the *Maximum Contaminant Level (MCL)* for fluoride at 4 mg/l.

Fluoride — A binary compound of *Fluorine* with another element; gaseous, solid, or dissolved compounds containing fluorine that result from industrial processes. Fluoride combines with tooth enamel to render it less soluble in acid environments and fluoride compounds are added to public water supplies to prevent tooth decay. Excessive amounts in food can lead to *Fluorosis*. Fluorine is a halogen with the chemical symbol F.

Fluorine — A pale-yellow, highly corrosive, poisonous, gaseous halogen element, the most electronegative and most reactive of all the elements, used in a wide variety of industrially important compounds. Fluorine is a halogen with the chemical symbol F.

Fluorosis — An abnormal condition caused by excessive intake of *Fluorine*, as from fluoridated drinking water, characterized chiefly by mottling of the teeth.

Flush — (1) To flow suddenly and abundantly, as from containment; flood. (2) To be emptied or cleaned by a rapid flow of water, as a toilet. (3) To open a cold-water tap to clear out all the water which may have been sitting for a long time in the pipes. In new homes, to flush a system means to send large volumes of water gushing through the unused pipes to remove loose particles of solder and flux. (4) To force large amounts of water through liquid to clean out piping or tubing, storage or process tanks. (5) (Engineering) To remove deposits of rock fragments and other debris by flushing them with a high-velocity stream of water.

Flushing Flows — Discharges, either natural or man-caused, of sufficient magnitude and duration to cause scouring and removal of fine sands from the streambed gravel to maintain intragravel permeability.

Flushing of Fish — The downstream movement of fish because of water velocity.

Flushing Period — The theoretical amount of time necessary for a quantity of water equal to the entire volume of a given lake to pass through its outlet.

Flushless Toilet — A toilet that disposes of waste without using water, especially one that utilizes bacteria to break down waste matter.

Flushometer — A device for flushing toilets and urinals that utilizes pressure from the water supply system rather than the force of gravity to discharge water into the bowl, designed to use less water than conventional flush toilets.

Fluve — A linear depression, rill, gully, arroyo, canyon, valley, etc., of any size, along which flows at some time, a drainageway.

Fluvial — (1) Of or pertaining to rivers and streams; growing or living in streams or ponds; produced by the action of a river, stream or flood flow, as in a fluvial plain. (2) Relating to or produced by a river or the action of a river. (3) Situated in or near a river or stream. (4) (Biology) Living or growing in or near a river or stream.

Fluvial Deposit — (Geology) An accumulation of sedimentary material carried by, suspended in, and deposited by a stream.

Fluvial Geomorphology (Geomorphologist) — The science concerned specifically with the influences of water and rivers on the erosional cycle of land deposition and degradation over time. While hydrology concentrates on the description, measurement, and analysis of precipitation and the flow of water on the earth's surface and underground, fluvial geomorphology concentrates on understanding the processes that govern the influence of water on the landscape over time.

Fluvioglacial — Pertaining to streams flowing from glaciers or to the deposits made by such streams.

Fluviology — The scientific study of rivers.

Flux — (1) A flowing or flow. (2) The flowing in of the tide. (3) The measure of the hydraulic rate of flow of water through a pressure osmosis membrane in gallons per square foot of membrane per day (GFD).

Flux Density — The rate of flow of any quantity, usually a form of energy, through a unit area of specified surface.

Foam — (1) A mass of bubbles of air or gas in a matrix of liquid film, especially an accumulation of fine, frothy bubbles formed in or on the surface of a liquid, as from agitation or fermentation. (2) The sea.

Foam Crust — A feature of a snow surface that resembles small overlapping waves or sea foam on a beach.

Foaming Agent — See *Surfactant*.

Fog — Condensed water vapor in cloud-like masses lying close to the ground.

Fog Climax — (Ecology) A community whose stability is dependent on the presence of a *Fog Bank*.

Fog Deposit — A coating of ice formed on an exposed surface by the freezing of *Fog*.

Fog Drip — (1) Water that drips to the ground from objects, such as leaves and branches, on which the water has collected during a *Fog*. (2) Water that is collected on the surface of vegetation and falls to the ground, as warm, moist air is advected over the vegetation.

Foggaras — Underground infiltration galleries or tunnels constructed by connecting shafts sunk in the detrital fans of piedmont regions in order to concentrate water moving underground into definite channels. They are known as foggaras in North Africa and as kanats or karezes in the Near East.

Fold — (Geology) A bend or flexure in a layer or layers of rock.

Foliated Ice — A frequently wedge-shaped large mass of ice that occupies a crack formed as a result of thermal contraction in permafrost. Also referred to as *Foliated Ground Ice*.

Food Chain — A succession of organisms in an ecological community that constitutes a continuation of food energy from one organism to another as each consumes a lower member and in turn is preyed upon by a higher member.

Foot Valve — A special type of check valve located at the bottom end of the suction pipe on a pump. This valve opens when the pump operates to allow water to enter the suction pipe but closes when the pump shuts off to prevent water from flowing out of the suction pipe.

Footslope — The relatively gently sloping, slightly concave slope component of an erosional slope that is at the base of the backslope component. Synonymous with *Pediment*.

Forage — Food for livestock and wildlife, especially taken by browsing or grazing.

Forage Fish — Small fish which breed prolifically and serve as food for predatory fish.

Forb — (1) Any *Herbaceous* flowering plant, other than a grass; especially one growing under range conditions. (2) An herbaceous plant other than a *Graminoid*.

Force Mains — Pipes in which wastewater is transported under pressure; the system is used in some areas having small elevation changes with distance and therefore needing to augment the gravity flow.

Force Pump — A pump with a solid piston and valves used to raise a liquid or expel it under pressure.

Ford — (1) A shallow place in a body of water, such as a river, where one can cross by walking or riding on an animal or in a vehicle. (2) An at-grade stream crossing that uses the bottom of the channel in lieu of a bridged or culverted crossing.

Forebay — (1) A portion of a groundwater basin where large quantities of surface water can recharge the basin through infiltration. (2) The water behind a dam. A reservoir or pond situated at the intake of a pumping plant or power plant to stabilize water levels; also a storage basin for regulating water for percolation into groundwater basins. Compare with *Afterbay*.

Forebay Reservoir — A reservoir used to regulate the flow of water to a hydroelectric plant; it may also serve other purposes such as recreation. Also see *Afterbay*.

Forebay Zone — Same as the *Lacustrine Zone* of a reservoir.

Forecast (Forecasting) — (Statistics) A forecast is a quantitative estimate (or set of estimates) about the likelihood of future events based on past and current information. This “past and current information” is specifically embodied in the structure of the econometric model used to generate the forecasts. By extrapolating the model out beyond the period over which it was estimated, we can use the information contained in it to make forecasts about future events. It is useful to distinguish between two types of forecasting, *ex post* and *ex ante*. In an *ex post* forecasts all values of dependent and independent variables are known with certainty and therefore provides a means of evaluating a forecasting model. Specifically, in an *ex post* forecast, a model will be estimated using observations excluding those in the *ex post* period, and then comparisons of the forecasts will be made to these actual values. An *ex ante* forecast predicts values of the dependent variable beyond the estimation period using values for the explanatory variables which may or may not be known with certainty.

Forecast Horizon — (Statistics) The number of time periods to be forecasted; also, the time period in the future to which forecasts are to be made.

Foreshore — (1) The part of a shore that lies between high and low watermarks. The lower shore zone, between normal low and high water levels. (2) The part of a shore between the water and occupied or cultivated land. (3) (Geology) The area of a beach or shore that is regularly covered and uncovered by the rise and fall of the tide, extending from the normal low-tide mark to the normal high-tide mark.

Forest — In general, an area or biotic community dominated by trees of any size (usually, at least 10 percent of the area is covered by trees). If distinction is made to woodlands, forests are composed of taller, more closely-spaced trees.

Forest Health — A condition wherein a forest has the capacity across the landscape for renewal, for recovery from a wide range of disturbances, and for retention of its ecological resiliency, while meeting current and future needs of people for desired levels of values, uses, products, and services.

Forest Hydrology — The study of hydrologic processes as influenced by forest and associated vegetation.

Forest Influences — The effects resulting from the presence of forest or brush upon climate, soil water, runoff, streamflow, floods,

erosion, and soil productivity.

Forest Land — Land which is at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for non-forest use. Lands developed for non-forest use include areas for crops, improved pasture, residential, or administrative areas, improved roads of any width, and adjoining road clearing and power line clearing of any width.

(United States) Forest Service (USFS) [USDA] — The largest and most diverse agency of the U.S. Department of Agriculture (USDA), the Forest Service provides leadership in the management, protection, and use of the nation's forests and rangelands, which comprise almost two-thirds of the nation's federally owned lands. The creation of the Forest Service goes back to 1891 when the President was authorized to establish Forest Reserves from forest and range lands in the *Public Domain*. In 1905 the responsibilities for the management and protection of these Forest Reserves was transferred from the Department of the Interior to the Department of Agriculture and the Forest Service was formally established. The Forest Reserves were then renamed National Forests. Today the Forest Service manages 156 National Forests, 19 National Grasslands, and 16 Land Utilization Projects that make up the National Forest System located in 44 states, Puerto Rico, and the Virgin Islands. Much of the nation's fresh water supply flows from National Forest System lands and insuring adequate yields of high quality water and continuing soil productivity are primary aims of the Forest Service's watershed management programs. The Forest Service manages more than 14 percent of the nation's 1.2 billion acres of forest range. This National Forest System (NFS) rangeland is managed to conserve the land and its vegetation while providing food for both domestic livestock and wildlife. The Forest Service manages fish and wildlife habitat on the National Forests and National Grasslands in cooperation with the individual states' fish and game departments. Of the 191 million acres of National Forests, 86.5 million acres are classified as commercial forests, available for, and capable of, producing crops of industrial wood. National Forest timber reserves are managed on a sustained-yield basis to produce a continuous supply of wood products to meet the nation's economic demands while maintaining the productive capacity of these lands. In 1924 the Forest Service pioneered the establishment of wilderness areas on National Forest lands. National Forest lands are a major source of mineral and energy supplies with regulatory and management responsibilities for mineral activities shared with the Department of the Interior, Bureau of Mines. The Forest Service, with one of the world's largest wildland firefighting forces, provides direct fire protection and control for National Forest System lands as well as cooperative fire control on several million additional acres. The Forest Service is responsible for the forest management aspects of the Watershed Protection and Flood Prevention Program administered by the *Natural Resources Conservation Service (NRCS)*. The Forest Service also participates in the forestry aspects of the River Basin Program, which guides and coordinates water and related land resource planning among several federal departments. The Forest Service operates an extensive forestry research program consisting of eight Forest and Range Experiment Stations, a Forest Products Laboratory, and 75 research labs located throughout the U.S., Puerto Rico, and the Pacific Trust Territories. The Forest Service is organized into nine (9) regions as listed below (regional headquarters are in parentheses):

- [1] **Eastern Region (Milwaukee, Wisconsin)** — Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, Ohio, Indiana, Michigan, Illinois, Missouri, Iowa, Wisconsin, Minnesota;
- [2] **Southern Region (Atlanta, Georgia)** — Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas;
- [3] **Rocky Mountain Region (Denver, Colorado)** — South Dakota, Nebraska, Kansas, Wyoming, Colorado;
- [4] **Northern Region (Missoula, Montana)** — North Dakota, Montana, Idaho (northern part only), South Dakota (northwest corner only), Wyoming (northwest corner only);
- [5] **Intermountain Region (Ogden, Utah)** — Nevada, Utah, Idaho (except northern portion), Wyoming (western portion only);
- [6] **Southwest Region (Albuquerque, New Mexico)** — Arizona, New Mexico;
- [7] **Pacific Northwest Region (Portland, Oregon)** — Washington, Oregon;
- [8] **Pacific Southwest Region (San Francisco, California)** — California, Hawaii;
- [9] **Alaska Region (Juneau, Alaska)** — Alaska.

Forfeited Water Right — A water right that is no longer valid because of five or more consecutive years of nonuse. Also see *Abandoned Water Right*.

Forfeiture — When any person entitled to the use of appropriated water fails to use beneficially all or any part of such water for the purpose for which it was appropriated, for a certain period of time, such unused water shall revert to the public and shall be regarded as unappropriated public water.

Forfeiture (Water Right) — (1) The loss of a water right through nonuse for a specified period of time; can occur involuntarily. (2) The invalidation of a water right because of five or more consecutive years of nonuse. Compare to *Abandonment (Water Right)*.

Fork — (1) Any place where two or more streams unite to form a larger waterway. (2) The land lying within the angle made by such streams. (3) A branch of a larger stream.

Formation — (Geology) (1) A body of rock or soil of considerable thickness that has characteristics making it distinguishable from adjacent geologic structures. (2) A lithologically distinctive product of essentially continuous sedimentation selected from a local succession of strata as a convenient unit for mapping, description, and reference. (3) Something naturally formed, commonly differing conspicuously from adjacent objects or material, or being noteworthy for some other reason.

Formation Stabilizer — A sand or gravel placed in the annulus of the well between the borehole wall and the well screen to provide temporary or long-term support for the borehole.

Formation Water — Water that is present in a formation under natural conditions, as opposed to being introduced artificially.

Fosse — (1) A long, narrow waterway, such as a canal or a trench. Also referred to as *Foss*. (2) A long, narrow trough-like depression between the edge of a retreating *Glacier* and the containing wall of its valley, or between the front of a *Moraine* and its outwash plain.

Fossil Fuels — (1) A fuel that contains energy locked up in chemical compounds by the plants and animals of former ages. (2) Combustible gases, liquids, and solids found in the earth's crust, resulting from the metamorphosis of plants and animals living in past geologic ages. For example, coal, petroleum, and natural gas.

Fossil Ice — (1) Ice found in frigid regions where it remains from the recent geologic past in which it was originally formed. (2) Relatively old ice found beneath the surface in a *Permafrost* region. (3) Underground ice found in areas where present-day temperatures are not low enough to have formed it.

Fossil Water — Limited subterranean water deposits laid down in past ages but drawn on by modern man.

Foucault, Jean Bernard Léon (1819–1868) — A French physicist who estimated the speed of light and determined that it travels more slowly in water than in air (1850).

Fouling — The process in which undesirable foreign matter accumulates in a bed of filter media or ion exchanger, clogging pores and coating surfaces and thus inhibiting or retarding the proper operation of the bed.

Fouling Organism — (Ecology) (1) One of a collection of aquatic organisms growing on the surface of floating or submerged synthetic structures and thus decreasing water flow or otherwise interfering with the function of the structure. (2) Any organism whose presence interferes with the operation of the object on which it grows. For example, see *Zebra Mussel*.

Foundation (of a Dam) — The natural material on which the dam structure is placed.

Founder — To sink below the water.

Fountain — (1) An artificially created jet or stream of water; a structure, often decorative, from which a jet or stream of water issues. (2) A spring, especially the source of a stream. (3) A reservoir or chamber containing a supply of liquid that can be siphoned off as needed.

Fountainhead — (1) A spring that is the source or head of a stream. (2) The upper end of a confined-aquifer conduit, where it intersects the land surface.

FR — Federal Register.

Fractionation — Separation of a substance from a mixture.

Fracture — A general term for any break in rock, which includes cracks, joints, and faults.

Fractured Bedrock Aquifer — An aquifer composed of solid rock, but where most water flows through cracks and fractures in the rock instead of through pore spaces. Flow through fractured rock is typically relatively fast.

Fragile Area — Areas that, due to steepness, soil type, exposure, and cover, are especially subject to soil erosion and rapid deterioration. Also referred to as *Critical Area*.

Fragmentation (of Habitat) — (Ecology) (1) A process by which large, contiguous blocks of habitat are broken into smaller patches isolated from each other by a landscape matrix dissimilar to the original habitat. (2) Interruption of large expanses of one type of habitat or vegetation by man-made clearings. Generally used where roads or areas of cropland are cleared within forested areas, thereby breaking a large continuous area of forest into smaller parcels of forest.

Frazil — (1) Small, disk-shaped or needle-shaped ice crystals formed in supercooled, turbulent water. (2) A French-Canadian term for the fine spicular ice, derived from the French words for cinders which this variety of ice most resembles. When formed in slat water it is known as *Lolly Ice*. When first formed, frazil is colloidal and is not visible in the water.

Frazil Ice — A spongy, slushy aggregate or mass of *Frazil* suspended in supercooled, turbulent water. Also referred to as *Needle Ice*.

Free Available Chlorine Residual — The application of chlorine to water to produce a free available chlorine residual equal to at least 80 percent of the total residual chlorine (sum of free and combined available chlorine residual).

Free Available Residual Chlorine — That portion of the total available residual chlorine composed of dissolved chlorine gas (Cl₂), hypochlorous acid (HOCl), and/or hypochlorite ion (OCl⁻) remaining in water after chlorination. This does not include chlorine that has combined with ammonia, nitrogen, or other compounds.

Free Flow — (Hydraulics) Flow through or over a structure not affected by submergence or backwater.

Free-Flowing — Flowing without artificial restrictions.

Free-Flowing Stream — A stream or a portion of a stream that is unmodified by the works of man or, if modified, still retains its natural scenic qualities and recreational opportunities.

Free-Flowing Weir — A weir that in use has the tailwater lower than the crest of the weir.

Free-Flowing Well — An *Artesian Well* in which the potentiometric surface is above the land surface. Also see *Potentiometric Surface*.

Free Groundwater — Water in interconnected pore spaces in the *Zone of Saturation* down to the first impervious barrier, moving under the control of the water table slope.

Free Liquids — (Water Quality) Liquids capable of migrating from waste and contaminating groundwater. Hazardous waste containing free liquids may not be disposed of in landfills.

Free Meander — A river *Meander* that displaces itself very easily by the abrasive action of the sediment load along the banks of the stream.

Free Moisture — Liquid that will drain freely from solid waste by the action of gravity only. Also referred to as *Free Water*.

Free Water — (1) Water in the soil that is in excess of field capacity and that is thus free to move into the groundwater zone in response to gravitational force. Also referred to as *Gravity Water*. (Chemistry) (2) Water that can be removed from another substance without changing the structure or composition of the substance. (3) In a container holding both water and a suspension

of water in another liquid, the water that is not in suspension. (4) (Biochemistry) The portion of water in body tissues that is not bound by macromolecules or organelles. (4) (Petroleum Engineering) The water in permeable reservoir rock that usually surrounds oil and gas.

Free-Water Content — The quantity of liquid water present within a sample of wet snow.

Free Water Surface (FWS) Constructed Wetland — A type of constructed wetland, a man-made marsh-like area used to treat wastewater. In this type of wetland, the effluent flows through various aquatic plants, with the water level exposed to the air. While this type of wetland is relatively easy to construct, it is not as effective as the *Subsurface Flow (SF) Constructed Wetland* with respect to associated odors, potential for insect breeding, and risk of public exposure and contact with the water in the system. Also see *Wetlands, Benefits*.

Freeboard — (1) The vertical distance between a design maximum water level and the top of a structure such as a channel, dike, floodwall, dam, or other control surface. The freeboard is a safety factor intended to accommodate the possible effect of unpredictable obstructions, such as ice accumulation and debris blockage, that could increase stages above the design water surface. (2) The vertical distance from the normal water surface to the top of the confining wall. (3) The vertical distance from the sand surface to the underside of a trough in a sand filter. This distance is also called available expansion. (4) (Nautical) The distance between the water line and the uppermost full deck of a ship. For dams, the terms “net freeboard”, “dry freeboard”, “flood freeboard”, or “residual freeboard” refer to the vertical distance between the estimated maximum water level and the top of a dam. “Gross freeboard” or “total freeboard” is the vertical distance between the maximum planned controlled retention water level and the top of a dam. (3) (FEMA) A factor of safety expressed in feet above a design flood level for flood protective or control works. Freeboard is intended to allow for all of the uncertainties in analysis, design and construction which cannot be fully or readily considered in an analytical fashion.

Freestone Water — Water that contains little or no dissolved material.

Freeze — (1) To pass from the liquid to the solid state by loss of heat. (2) To acquire a surface of coat of ice from cold.

Freeze-Out Lake — A term for a very shallow lake that is usually frozen over for long periods of time.

Freeze-Up (or Freezepup) — (1) The formation of a continuous cover of ice on a body of water. (2) The period during which a particular body of water is frozen over.

Freezing — The change of a liquid into a solid as temperature decreases. For water, the freezing point is 32EF (Fahrenheit) or 0EC (Celsius).

Freezing Nuclei — Particles that initiate the development and growth of ice crystals by inducing freezing.

Freezing Point — (1) The temperature at which a liquid of specified composition solidifies under a specified pressure. (2) The temperature at which the liquid and solid phases of a substance of specified composition are in equilibrium at atmospheric pressure.

Freezing Rain — Water that freezes upon reaching a surface, the temperature of which is below freezing.

Freezing Rain or Drizzle — Precipitation that falls as supercooled liquid water and freezes upon impact to form a coating of *Glaze*.

French Drain — An underground passageway for water through the interstices among stones placed loosely in a trench.

Frequency Analysis — A statistical procedure involved in interpreting the past record of a hydrological event to occurrences of that event in the future (e.g., estimates of frequencies of floods, droughts, storage, rainfall, water quality, etc.).

Frequency Curve — A graphical representation of the frequency of occurrence of specific events. Also referred to as *Frequency Distribution*.

Frequency Distribution — An arrangement of quantities pertaining to a single event, in order of magnitude and frequency of occurrence.

Fresh — (1) Not saline or salty. (2) Free from impurity or pollution. See *Fresh Water*.

Fresh Ice — Ice that was formed on salt water but is now salt free. Also see *Young Ice* and *Freshwater Ice*.

Fresh-Salt Water Interface — The region where fresh water and salt water meet.

Fresh Water (or Freshwater) — (1) Of, relating to, living in, or consisting of water that is not salty. (2) Water with no significant amount of dissolved salts or minerals, as is normally found in streams and lakes. (3) In general, water with salinity less than 0.5‰ (parts per thousand) dissolved salts. (3) Generally, water that contains less than 1,000 milligrams per liter (mg/l) of dissolved solids; generally, more than 500 mg/l of dissolved solids is undesirable for drinking and many industrial uses. (4) (Biology) Related to aquatic animals living or found in fresh water as opposed to ocean or salt water. (5) (Nautical) Accustomed to sailing on inland waters only as a fresh water sailor. Also see *Sweet Water*.

Fresh Water (Dissolved Solid Content) — Generally, fresh water has a *Total Dissolved Solids (TDS)* concentration of less than 1,500 ppm (i.e., 1,500 parts per million or milligrams-per-liter of dissolved solids). Brackish waters are highly mineralized and have a TDS concentration between 1,500 ppm and 15,000 ppm. Saltwaters have a TDS concentrations greater than 15,000 ppm.

Freshet — (1) A sudden overflow of a stream resulting from a heavy rain or a thaw. (2) A sudden rise or overflowing of a small stream as a result of heavy rains or rapidly melting snow. Also referred to as *Spate* or *High Water*. (3) A small, clear, freshwater stream. (4) A stream of fresh water that empties into a body of salt water.

Freshwater Ecosystem — (Ecology) An area of water, either stagnant or free-flowing, characterized by low salt content.

Freshwater Ice — Ice formed by the freezing of fresh water in streams and lakes.

Freshwater Initiative (FWI) [The Nature Conservancy] — A relatively new and innovative program of *The Nature Conservancy (TNC)* to dramatically increase freshwater conservation in the United States, Latin America, and the Caribbean. As noted by TNC, mighty, rolling, and free flowing rivers have always drawn us. We travel their arteries. We drink of their waters and irrigate our fields with their flow. We take fish from them, for food and sport, just as we take pleasure from swimming and boating in them. They also brim with an extraordinary diversity of native plants and animals. Yet, this natural wealth faces serious threats. Across the Americas, rivers are dammed, smothered with soil erosion, and lined with development. The United

States, where freshwater *Biodiversity* is comparable to the terrestrial diversity of the world's great tropical rain forests, has already lost more than half of its wetlands and riverside ecosystems. Accordingly, TNC states that our rivers, lakes, and streams deserve immediate and concerted attention. To meet this challenge, TNC launched its Freshwater Initiative in 1998. Through this program, TNC will bring a growing expertise in freshwater conservation to bear at more than 30 sites; empower TNC field staff with new skills, capacity, and access to specialized expertise; and provide others involved in water and land management with new knowledge and appropriate solutions for achieving conservation success. The FWI consists of three strategies:

- [1] **Watershed Action** – In communities across the Americas, TNC site teams are working with private and public partners – from farmers to federal water managers – to reduce two of the most pervasive threats to freshwater ecosystems: (a) altered natural water flows and (b) farm run-off pollution. Solving these complex problems requires creative and innovative strategies, consensus building and significant resources. The FWI will help site teams craft solutions which offer the greatest promise of success in meeting ecosystem needs while balancing human demands for water. Solutions may include removing or changing how dams operate, protecting groundwater spring flows, or working with farmers to implement environmentally-friendly best practices.
- [2] **Water Science** – How do we set priorities for future freshwater biodiversity conservation in a particular region? Which particular rivers or lakes deserve immediate conservation attention? To answer these and other related questions, TNC staff developed, and are now applying, a powerful new tool – an aquatic community classification system. Using this system, TNC can map existing locations of freshwater animals and their habitats across broad regions and assess their relative conservation priority.
- [3] **Water Lessons** – Freshwater conservation success requires more than application of solutions at individual sites and selecting places for future conservation action. Freshwater conservationists will need to become more creative, more collaborative, and more knowledgeable. Recognizing this need, the FWI includes a Freshwater Learning Center – a communications and networking system for leveraged learning. Using all available technologies – live meetings and conferences, the internet, literature, and video – the Learning Center will offer freshwater site teams access to training relevant to freshwater conservation, provide staff and partners working at individual sites with opportunities to learn from the efforts of other freshwater conservation practitioners, and develop and disseminate key information and insights to broader audiences.

Freshwater Marsh — (1) Open wetlands that occur along rivers and lakes, and in many other areas. Sedges, reeds, rushes, and grasses are the dominant plants in freshwater marshes. (2) A *Circumneutral Ecosystem* of more or less continuously water-logged soil dominated by emerged herbaceous plants, but without a surface accumulation of peat.

Freshwater Swamps — Forested or shrubby wetlands. *Pocosins* and heaths are two examples of freshwater swamps.

Fret — To gnaw or wear away; erode. To form (a passage or channel) by erosion. To disturb the surface of (water or a stream); agitate.

Friable — (1) Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft or poorly cemented sandstone. (2) Said of a soil consistency in which moist soil material crushes easily under gentle to moderate pressure (between thumb and forefinger) and coheres when pressed together.

Friction Head — Energy required to overcome friction due to fluid movement with respect to the walls of the conduit or containing medium.

Friction Losses — (1) Total energy losses in the flow of water due to friction between the water and the walls of a conduit, channel, or porous medium, usually expressed in units of height. (2) The head, pressure or energy (they are the same) lost by water flowing in a pipe or channel as a result of turbulence caused by the velocity of the flowing water and the roughness of the pipe, channel walls, and restrictions caused by fittings. Water flowing in a pipe loses pressure or energy as a result of friction losses. Also see *Head Loss*.

Friction Slope — The energy loss per unit of length of open or closed conduit due to friction.

Friends of the Earth (FOE) — A conservation and environmental organization, founded in 1969, dedicated to preservation, restoration, and wise use of natural resources. The United States headquarters is located in Washington, D.C., with affiliates offices in 37 countries. Through the *Friends of the Earth Foundation*, the organization promotes public education and monitors enforcement of environmental policies.

Fringe Water — Water occurring in the *Capillary Fringe*. Also see *Anastatic Water*.

Fringe Marsh — A saturated, poorly drained area, intermittently or permanently water covered, close to and along the edge of a land mass.

Front — (1) Land bordering a lake or river. (2) (Meteorology) A line of separation or interface between air masses of different temperatures or densities.

Frontage — Land adjacent to something, such as a body of water.

Frontal Moraine — See *End Moraine*.

Frost — (1) A white, feathery deposit of interlocking ice crystals formed by the sublimation of water vapor on a surface whose temperature is below freezing. (2) Thin ice crystals in the shape of scales, needles, feathers or fans which are deposited by *Sublimation* at temperatures of 32°F (0°C) or lower. (3) A temperature low enough to cause freezing. (4) The process of freezing. Also refers to *Hoarfrost*. Also see *Permafrost*.

Frost Boil — (Geology) (1) An accumulation of water and mud that is released from ground ice by accelerated spring thawing. (2) A low mound formed by local differential *Frost Heaving* at a location that is favorable for the formation of segregated ice and lacking an insulating cover of vegetation.

Frost Cracks — Steep fractures formed by thermal contraction in rock or frozen ground with substantial ice content. They

commonly intersect to create polygonal patterns, which may lead to the formation of wedges of ice and surficial material. The frequency of cracking is linked to the intensity of winter cold. Where climate is warming, ice-wedge casts replace ice wedges over periods of decades.

Frost Heave — Ruptured soil, rock, or pavement caused by the expansion of freezing water immediately beneath the surface. Also see *Frost Heaving*.

Frost Heaving — (Geology) (1) The uneven upward expansion and distortion of the ground caused by the freezing of subsurface water, and affecting soil, rock, pavement, and other structures. (2) Any upheaval of the ground as a result of frost action. (3) A basic physical process associated both with near surface winter freezing and with deeper *Permafrost* aggradation. Frost heaving can displace buildings, roads, pipelines, drainage systems and other structures. Many frozen soils have a much greater water content than their dry equivalents and undergo a local 10-20 percent expansion in soil volume during freezing. The frost heave process and the consequences of thawing are of great importance in the development of many of the unique features of cold terrains, including perennial hummocks and seasonal mounds, patterned ground, palsas and pingos.

Frost Line — (1) The depth to which frost penetrates the earth. (Geology) (2) The maximum depth of frozen ground or soil during the winter in non-permafrost regions. (3) The lowest limit of permanently frozen ground in frigid regions. (3) The altitude below which freezing does not occur in tropical regions.

Frost Mound — (Geology) Any knoll, hill, or conical mound containing a core of ice and formed by *Frost Heaving* or hydrostatic pressure of groundwater in a permafrost region. Also referred to as a *Soil Blister* or *Soffosion Knob*.

Frost Pockets — A low area or depression at the base of a slope where frost collects.

Frost Point — The temperature at which atmospheric moisture will sublime in the form of hoar frost on a surface. It is analogous to the dew point and dew.

Frost Table — (Geology) An irregular ground surface that represents the degree to which thawing has taken place in seasonally frozen ground.

Froth — A mass of bubbles in or on a liquid; foam.

Frozen — (1) Made into, covered with, or surrounded by ice. (2) Very cold.

Frustule — The hard shell of a *Diatom*.

Fuels — The organic materials that support ignition and spread of a fire (duff, litter, grass, weeds, forbs, brush, trees, snags, and logs).

Fujita or F-Scale — A scale of wind damage intensity in which wind speeds are inferred from an analysis of wind damage. See *Tornado*.

Full Cost [USBR] — A water rate defined by Congress in the Reclamation Reform Act of 1982 intended to represent the federal government's actual cost in providing project water to irrigators. The full-cost rate for each project or district is calculated by amortizing the expenditures for construction properly allocable to irrigation facilities in service, including all operation and maintenance deficits funded, less payments, over such periods as may be required under federal reclamation law or applicable contract provisions. Interest on all charges accrues from October 12, 1982, on costs outstanding at that date or from the date incurred of costs arising subsequent to October 12, 1982. The term *Full-Cost Rate* means the full-cost charge plus actual operation, maintenance, and replacement costs.

Full-Cost Rate [USBR] — An annual rate as determined by the U.S. Secretary of the Interior that shall amortize construction expenditures that are properly allocable to irrigation facilities in service, including all operation and maintenance deficits funded, less payments, over such periods as may be required by reclamation law or applicable contract provisions, with interest on both accruing from October 12, 1982, on costs outstanding at that date, or from the date incurred in the cost of costs arising subsequent to October 12, 1982.

Fuller's Earth — (Geology) A fine-grained, naturally occurring, highly adsorptive clay or clay-like material composed primarily of montmorillonite; used as a bleaching, degreasing, or as a filtering agent, especially in the refining and decolorizing of oils.

Fully Developed Sea — (Oceanography) The maximum wave height or sea condition that can be generated by a wind of a given force blowing over sufficient fetch, regardless of duration.

Fully Permanent Sprinkler System — An irrigation system usually composed of buried enclosed conduits carrying water under pressure to fixed orifices to distribute water over a given area.

Fumarole — A hole or orifice in a volcanic region, and usually in lava, from which issue gases and vapors at high temperature.

Functional Equivalent — A term used to describe the *U.S. Environmental Protection Agency's (EPA)* decision-making process and its relationship to the environmental review conducted under the *National Environmental Policy Act (NEPA)*. A review is considered functionally equivalent when it addresses the substantive components of a NEPA review.

Functional Relationship — (Statistics) A hypothetical relationship that describes the effect of one or more *Independent Variables* on a *Dependent Variable*, of the general form:

$$Y = f(X_1, X_2, \dots, X_n)$$

where Y represents the dependent variable whose behavior is a function of, $f(\)$, the values of the independent variables, $X_1, X_2, \dots, X_n$. A fundamental assumption of a functional relationship is that changes in the independent variables, also referred to as the *Exogenous Variables*, prescribe or determine changes in the dependent, or *Endogenous Variable*, consequently leading to a flow of causation from the independent variables to the dependent variable. As such, a functional relationship is not exactly comparable to a mathematical equation in which variables may be moved from one side of the equation to the other without changing the validity of the equality. In a functional relationship by contrast, once the flow of causation has been prescribed (the *Specification*), the equation's (model's) structure is fixed.

Functionally Dependent Use [FEMA] — As defined by the *Federal Emergency Management Agency (FEMA)*, a use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking facilities and port facilities that are necessary for the loading and unloading of cargo or passengers, and ship building and ship repair facilities, and does not include long-term storage or related manufacturing facilities.

Fungi (Singular: Fungus) — (1) Mushrooms, molds, mildews, rusts, and smuts that are small non-chlorophyll-bearing plants lacking roots, stems and leaves. They occur in natural waters and grow best in the absence of light. Their decomposition may cause objectionable tastes and odors in water. (2) Molds, mildews, yeasts, mushrooms, and puffballs, a group of organisms lacking in chlorophyll (i.e., are not photosynthetic) and which are usually non-mobile, filamentous, and multicellular. Some grow in soil, others attach themselves to decaying trees and other plants whence they obtain nutrients. Some are *Pathogens*, others stabilize sewage and digest composted waste.

Fungicide — A chemical material used to retard or prevent the growth of fungi.

Furiose Lake — (Ecology) A subsidiary body of water that connects with the main body only at high water.

Furrow — A long, narrow, shallow trench made in the ground by a plow for planting and irrigation.

Furrow Dams — Small earth ridges or rows used to impound water in furrows.

Furrow Irrigation — Spreading water by directing it into small channels across the field. Also referred to as *Corrugation Irrigation*.

Furrow Stream — The size of water flow released into the furrow; the size of the stream is adjusted to prevent erosion, limited in amount to the capacity of the furrow, and as needed for the intake rates of the soil involved.

Future Use Permit — A water appropriation reserving a definite amount of water with a specified priority date.

G

Gabion — (1) A wire cage, usually rectangular, filled with cobbles and used as a component for water control structures or for channel and bank protection. (2) A bottomless wicker cylinder or basket, from 20 to 70 inches in diameter and from 33 to 72 inches high; used in engineering, when filled with stones, to form the foundation of a jetty.

GAC (Granular Activated Carbon) — In water treatment, granular activated carbon has been used mainly for taste and odor control, with some special applications that remove *Synthetic Organic Chemicals (SOCs)* or *Volatile Organic Chemicals (VOCs)* from contaminated water. Two basic forms of GAC are typically used: (1) a coal-based carbon manufactured as an adsorbent; and (2) a wood-based carbon manufactured primarily as a substrate for biological activity. Also see *Biological Activated Carbon (BAC) Process*.

Gage, or Gauge — (1) An instrument used to measure magnitude or position; gages may be used to measure the elevation of a water surface, the velocity of flowing water, the pressure of water, the amount of intensity of precipitation, the depth of snowfall, etc. (2) The act or operation of registering or measuring magnitude or position. (3) The operation, including both field and office work, of measuring the discharge of a stream of water in a waterway.

Gage Datum — (1) The arbitrary zero datum elevation which all stage measurements are made from. (2) The elevation of the zero point of the reference gage from which gage heights is determined as compared to sea level. This elevation is established by a system of levels from known benchmarks, by approximation from topographic maps, or by a *Geographical Positioning System (GPS)* or *Geographic Information System (GIS)*. Also see *Datum*.

Gage Height (G.H.) — The height of the water surface above the *Gage Datum* (reference level). Gage height is often used interchangeably with the more general term, *Stage*, although gage height is more appropriate when used with a gage reading.

Gage Pressure — The pressure within a closed container or pipe as measured with a gage. In contrast, absolute pressure is the sum of atmospheric pressure (14.7 lbs./sq. in.) plus the pressure within a vessel (as measured by a gage). Most pressure gages read in gage pressure or psig (pounds per square inch gage pressure).

Gage Rod — A measuring device that shows the water level in the reservoir.

Gage Zero — The elevation of zero stage. Also referred to as *Gage Datum*.

Gaging Station — (1) Section in a stream channel equipped with a gage and facilities for measuring the flow of water. (2) A particular site on a stream, canal, lake, or reservoir where systematic observations of *Gage Height* or discharge are obtained through mechanical or electrical means. When used in connection with a discharge record, the term is applied only to those gaging stations where a continuous record of discharge is computed. Also referred to as a *Gage*.

Gaging Station Number — A *U.S. Geological Survey (USGS)* numbering system consisting of an eight-digit number assigned to a *Gaging Station* which identifies the station in downstream order relative to other gaging stations and sites where streamflow data are collected. The first two digits designate the major drainage basin, the others the station.

Gaining Stream — A stream or reach of a stream, the flow of which is being increased by the inflow of groundwater seepage or from springs in, or alongside, the channel. Also referred to as an *Effluent Stream*. Also see *Stream*.

Gallery — (1) A passageway within the body of a dam or abutment; hence the terms “grouting gallery,” “inspection gallery,” and “drainage gallery.” (2) A long and rather narrow hall; hence the following terms for a power plant: “valve gallery,” “transformer gallery,” and “busbar gallery.”

Gallon (Imperial) — A unit of capacity in Great Britain containing four quarts, is used for both liquid and dry commodities, and is defined as the volume occupied by ten imperial pounds weight of distilled water, as weighed in air against brass weights with both water and air at 62°F, and the barometer at 30 inches (*atmospheric pressure*). It is equivalent to 4.5460 liters (277.420 U.S. cubic inches), or to 1.2003 U.S. gallons (defined below).

Gallon (U.S.) — A unit of capacity, containing four quarts, used in the United States primarily for liquid measure. One U.S. gallon contains 231 cubic inches, 0.133 cubic feet, or 3.7853 liters. One U.S. gallon is equivalent to the volume of 8.3359 pounds av. (avoirdupois) of distilled water at its maximum density (32.9°F or 4°C), weighed in dry air at the same temperature against brass weight of 8.4 density and with the barometer at 30 inches. It takes approximately 325,851 gallons to make up 1 acre-foot (AF). [Historical Note: The U.S. gallon is the same as the old English *wine gallon* which was originally intended in England to be equivalent to a cylinder of seven inches in diameter and six inches in height.]

Gallons per Capita (GPC) — A term used relative to water use per person per specified time, usually a day.

Gallons per Capita (Person) per Day (GPCD) — An expression of the average rate of domestic and commercial water demand, usually computed for public water supply systems. Depending on the size of the system, the climate, whether the system is metered, the cost of water, and other factors, *Public Water Supply Systems (PWSS)* in the United States experience a demand rate of approximately 60 to 150 gallons per capita per day. Also see *Gallons per Employee per Day (GED)* for information on the application of this concept to commercial water use by *Standard Industrial Classification (SIC) Code*.

Gallons per Employee (Worker) per Day (GED, or GPED) — A measure or coefficient expressing an area's commercial water use per worker (employee), typically for distinct industry sectors. It is based on an analytical technique for measuring and forecasting commercial water use in a service area based upon the unique, seasonal, business-related water use by specific

industrial sectors. GED commercial water-use coefficients are typically developed based upon *Standard Industrial Classifications (SIC)* codes for which comparable commercial water use and employment data are available. For forecasting more frequently than annually, GED coefficients will incorporate seasonal patterns (monthly or quarterly) as well. By deriving forecasts of trends in industry sector employment and combining them with appropriate, industry-specific GED coefficients, relatively accurate forecasts of the corresponding commercial water use may be obtained.

Gallons per Employee (Worker) per Working Day (GEWD, or GPEWD) — A modification of the *Gallons per Employee per Day* concept in which the measure of industrial water use is computer only for those days actually worked. See *Water Use, Industrial*, for actual survey figures of these measures.

Gallons per Minute — A unit expressing rate of discharge, used in measuring well capacity. Typically used for rates of flow less than a few cubic feet per second (cfs).

Galvanic Series — A list of metals and alloys presented in the order of their tendency to corrode (or go into solution). Also called the *Electromotive Series*. This is a practical application of the theoretical *Electrochemical Series*.

Galvanize — To coat a metal (especially iron or steel) with zinc to prevent corrosion. Galvanization is the process of coating a metal with zinc.

Gamma Radiation — High energy photons which are emitted by many radioactive substances.

Gamma Ray — A quantum of electromagnetic radiation emitted by a nucleus, each such photon being emitted as the result of a quantum transition between two energy levels of the nucleus.

Game Fish — Those species of fish considered to possess sporting qualities on fishing tackle, such as salmon, trout, black bass, striped bass, etc.; usually more sensitive to environmental changes than *Rough Fish*.

Gap Analysis — A method for determining spatial relationships between areas of high biological diversity and the boundaries of *National Parks*, *National Wildlife Refuges (NWR)*, and other preserves. The primary goal of Gap Analysis is to prevent additional species from being listed as threatened or endangered. Analyses are made and displayed using a *Geographic Information System (GIS)*. Estimates of diversity are often derived from known or hypothesized relationships between mapped plant communities and animal populations. In addition to the *National Biological Survey*, which serves as the primary coordinating agency, there are over 200 collaborating organizations involved in performing Gap Analysis on a state-by-state basis, including businesses, universities, and state, local, and federal government entities. [The term *Gap* originated from an initial *Biodiversity* study in Hawaii which showed that for certain sensitive animal species there existed a physical (geographic) gap between the species and its habitat and wildlife preserves (national parks, forests, wildlife protection areas, etc.), indicating potential limitations of species and habitat protection.]

Garnet — A group of hard, reddish, glassy, mineral sands made up of silicates of base metals (calcium, magnesium, iron and manganese). Garnet has a higher density than sand.

Gas — A state of matter; a substance that generally exists in the gaseous phase at room temperature.

Gas Chromatograph/Mass Spectrometer (GC/MS) — A highly sophisticated instrument that identifies the molecular composition and concentrations of various chemicals in water and soil samples.

Gas Chromatography (GC) — A method of separating chemical components of a mixture which involves the passage of a gaseous sample through a column having a fixed adsorbent phase. It is in widespread use in quantitatively analyzing volatile compounds.

Gas Chromatography/Flame Ionization Detector (GC/FID) — A laboratory analytical method used as a screening technique for semi-volatile organic compounds that are extractable from water in methylene chloride.

Gasification — The process of combining coal with air (or pure oxygen) and steam to yield a gaseous product suitable for use either as a direct source of energy or as a raw material used in the synthesis of chemicals, liquid fuels, or other gaseous fuels.

Gate — (1) (Irrigation) Structure or device for controlling the rate of water flow into or from a canal, ditch, or pipe. (2) (River) Narrow, short passage between two obstacles. (3) (Dam) A device in which a leaf or member is moved across the waterway from an external position to control or stop the flow. The following types of gates apply to dams and other such structures:

- [1] **Bulkhead Gate** — A gate used either for temporary closure of a channel or conduit to empty it for inspection or maintenance or for closure against flowing water when the head differential is small, e.g., a diversion tunnel closure. Although a bulkhead gate is usually opened and closed under nearly balanced pressures, it nevertheless may be capable of withstanding a high pressure differential when in the closed position.
- [2] **Crest Gate (Spillway Gate)** — A gate on the crest of a spillway to control overflow or reservoir water level.
- [3] **Emergency Gate** — A standby or reserve gate used only when the normal means of water control is not available.
- [4] **Fixed Wheel Gate (Fixed Roller Gate, Fixed Axle Gate)** — A gate having wheels or rollers mounted on the end posts of the gate. The wheels bear against rails fixed in side grooves or gate guides.
- [5] **Flap Gate** — A gate hinged along one edge usually either the top or bottom edge. Examples of bottom-hinged flap gates are tilting gates and fish belly gates, so-called due to their shape in cross section.
- [6] **Flood Gate** — A gate to control flood release from a reservoir.
- [7] **Guard Gate (Guard Valve)** — A gate or valve that operates fully open or closed. It may function as a secondary device for shutting off the flow of water in case the primary closure device becomes inoperable, but is usually operated under balanced pressure, no-flow conditions.
- [8] **Outlet Gate** — A gate controlling the outflow of water from a reservoir.
- [9] **Radial Gate (Tainter Gate)** — A gate with a curved upstream plate and radial arms hinged to piers or other supporting structures.
- [10] **Regulating Gate (Regulating Valve)** — A gate or valve that operates under full pressure and flow conditions to throttle and vary the rate of discharge.

[11] **Slide Gate (Sluice Gate)** — A gate that can be opened or closed by sliding it in supporting guides.

Gated Pipe — (Irrigation) Portable pipe with small gates installed along one side for distributing water to corrugations or furrows.

Gauge, Pipe — A number that defines the thickness of the sheet used to make steel pipe. The larger the number, the thinner the pipe wall.

GC–MS — An analytical technique involving the use of both *Gas Chromatography (GC)* and *Mass Spectrometry (MS)*, the former to separate a complex mixture into its components and the latter to deduce the atomic weights of those components. It is particularly useful in identifying organic compounds.

GED (Gallons per Employee per Day) — A coefficient system for measuring and forecasting commercial water use by *Standard Industrial Classification (SIC) Code*. See *Gallons Per Employee (Worker) Per Day (GED)*.

Gel — (Water Quality) (1) A jellylike material formed by the coagulation of a colloidal suspension or sol. (2) A state of a colloidal suspension in which shearing stresses below a certain finite value fail to produce permanent deformation. Gels commonly occur when the dispersed colloidal particles have a great affinity for the base fluid.

Gel Strength — The minimum shearing stresses that will produce permanent deformation of a colloidal suspension.

General Circulation Models (GCMs) — Computer-generated models that make projections of climatic conditions through the use of various factors such as atmospheric circulation, biospheric modeling and oceanic circulation. An extension of this methodology is the general circulation and conceptual hydrologic models which attempt to predict more regional and hydrographic basin precipitation and runoff patterns (discharge) based on changing global climatic conditions.

(Truckee River) General Electric Decree [California] — Represented the resolution, through a 1915 federal court consent decree, of a lengthy series of conflicts, litigation, and negotiations between the *U.S. Bureau of Reclamation (USBR)*, then the *U.S. Reclamation Service, USRS* and the *Truckee River General Electric Company* (predecessor to the present-day *Sierra Pacific Power Company*), which, in 1902, through a complicated series of real estate transactions had obtained title to the Lake Tahoe Dam, surrounding lands, and the hydropower plants on the Truckee River. The Bureau of Reclamation was in desperate need of Lake Tahoe water for its *Newlands Irrigation Project*, then nearing completion near Fallon in Churchill County. This decree granted the Bureau of Reclamation an easement to operate the Lake Tahoe Dam and to use surrounding property owned by the power company. On its part, the Bureau of Reclamation was required to provide certain year-round flow rates (the *Floriston Rates*), measured at a stream gage near the state line, to support hydropower generation. These rates, in fact, dated back to a 1908 river flow agreement among the Truckee River General Electric Company, the Floriston Land and Power Company, and the Floriston Pulp and Paper Company and required that "...there shall be maintained a flow of water in the said Truckee River at Floriston [California] of not less than 500 cubic feet per second from the First day of March to the 30th day of September inclusive, in each year, and of not less than 400 cubic feet per second from the 1st day of October to the last day of February, inclusive, in each year." While this decree did dictate how the Lake Tahoe Dam would be operated, it did little to solve the concerns of residents of the lake and lessen California's concerns over the apportionment of Lake Tahoe waters.

General Improvement District (GID) [Nevada] — A public entity created under the provisions of the Nevada Revised Statutes and authorized by the respective county commission to provide specific services to a limited geographical area. A GID may be formed to provide one or a combination of services such as road maintenance, parks and recreation facilities, water and sanitary sewer service, etc.

General Stream Adjudication — A judicial proceeding to determine the extent and validity of all water rights within a given geographic area, for example, along a given river reach, throughout one or more river basins, or within a state.

Generation of Waves — (Oceanography) (1) The creation of waves by a natural or a mechanical process. (2) The creation of waves by a wind blowing over a body of water.

Generator — A machine that changes water power, steam power, or other kinds of mechanical energy into electricity.

Genotypes — The genetic constitution of an organism or group of organisms.

Geochemistry — Geochemistry, in the broad sense, includes all parts of geology that involve chemical changes; it may focus on the distribution of the elements.

Geochronology — The study of time in relation to the history of the earth; literally the science of earth time.

Geodetic — Refers to investigation of any scientific questions relating to the shape and dimensions of the earth.

Geographic Information System (GIS) — A computer information system that can input, store, manipulate, analyze, and display geographically referenced (spatial) data to support the decision-making processes of an organization. A map based on a database or databases. System plots locations of information on maps using latitude and longitude.

Geography — The science of the earth and life, especially the description of land, sea, air, and the distribution of plant and animal life, including man and his industries, with reference to the mutual relations among these diverse elements. As general areas of study, geography is divided into:

- [1] **Mathematical Geography** — Deals with the figure and motion of the earth, of its seasons, tides, etc., of its measurement, and of its representation on maps and charts by various methods of projection;
- [2] **Physical Geography** — Deals with the exterior physical features and changes of the earth's land, water, and air;
- [3] **Biological Geography** — Has to do with the relation of living things to their physical environment; and
- [4] **Commercial Geography** — Deals with commodities, their place of origin, paths of transactions, etc.

Geohydrology — (1) A term which denotes the branch of *Hydrology* relating to subsurface or subterranean waters; that is, to all waters below the surface. (2) The scientific study of subsurface water, especially the study of the geologic settings of underground water. Related terms include *Geohydrologic* and *Geohydrologist*.

Geoindicators [U.S. Global Change Research Information Office] — Measures relating to magnitudes, frequencies, rates, and trends of geological processes and phenomena occurring at or near the Earth's surface and subject to changes that are significant

in understanding environmental change over periods of 100 years or less. They measure both catastrophic events and those that are more gradual, but evident within a human life span. Geoindicators can be used to monitor and assess changes in fluvial, coastal, desert, mountain and other terrestrial areas. They can also be used through paleoenvironmental research to unravel trends over the past few centuries and longer, thus providing important baselines against which human-induced and natural stresses can be better understood. Geoindicators measure environmental change in terms that can be regarded as significant within the time span considered – presumably, not in amounts as low as parts per trillion (e.g. for contaminants) or as grams per square kilometer (erosion), or rates as slow as a few millimeters per 1,000 years (e.g. sea level changes). As defined, they do not apply to important earth processes that generally take place more slowly, such as diagenesis, metamorphism and deformation, and plate tectonic movements. Geoindicators describe processes and environmental parameters that are capable of changing without human interference, though human activities can accelerate, slow or divert natural changes. Humans are certainly an integral part of nature and the environment, but it is essential to recognize that nature and the environment are ever changing at one temporal and spatial scale or another, whether or not people are present. Environmental sustainability must, therefore, be assessed against a potentially moving background. Geoindicators have been developed from standard approaches used in geology, geochemistry, geophysics, geomorphology, hydrology and other earth sciences. Geoindicators have been developed during a three-year international project by the Commission on Geological Sciences for Environmental Planning (International Union of Geological Sciences). These indicators are designed to be used for environmental and ecological monitoring, state-of-the-environment reporting, and general assessments of environmental sustainability on local, national, and international scales. They help to answer four basic questions: (1) What is happening in the environment? (relating to conditions and trends); (2) Why is it happening? (relating to causes, links between human influences and natural processes); (3) Why is it significant? (relating to ecological, economic and health effects); and (4) What are we doing about it? (relating to implications for planning decisions and policy making). For additional information on specific water-related Geoindicators presented in this publication, see *Coral Chemistry and Growth Patterns, Glacier Fluctuations, Groundwater Chemistry in the Unsaturated Zone, Groundwater Level, Groundwater Quality, Karst Activity, Lake Levels and Salinity, Sediment Sequence and Composition, Soil and Sediment Erosion, Soil Quality, Stream Channel Morphology, Stream Sediment Storage and Load, Streamflow, Surface Water Quality, Wetlands Extent, Structure and Hydrology*.

Geologic Erosion — Normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of flood plains, coastal plains, etc. Also referred to as *Normal Erosion*.

Geologic Hazards — Geologic features or processes that are dangerous or objectionable to man and his works; they may be natural phenomena or man-induced phenomena.

Geologic (Geological) Log — (1) A detailed description of all underground features (e.g., depth, thickness, type of formation, etc.) discovered during the drilling of a well. (2) A record of the structure and composition of the earth encountered when drilling a well or similar type of test hole or boring.

Geologic Map — Map showing distribution of formations, folds, faults, and mineral deposits by appropriate symbols.

Geologic Section — A graphic representation of geologic conditions along a given line or plane of the earth's crust.

Geologic Time (History) — Geologic history can be divided into five great *Eras* of recorded time. These Eras and approximate time periods include:

Era	Time Periods
<i>Archeozoic</i>	4,500 million years ago (MYA) to 3,500 MYA
<i>Proterozoic</i> (or <i>Prepaleozoic</i>)	3,500 MYA to 586 MYA
<i>Paleozoic</i>	570 MYA to 230 MYA
<i>Mesozoic</i>	230 MYA to 65 MYA
<i>Cenozoic</i>	65 MYA to present

Each time Era (except the first – Archeozoic) is divided into *Periods* (e.g., the Cenozoic Era is divided into the *Tertiary* and *Quaternary* Periods) and Periods are further divided into *Epochs* (e.g., the Tertiary Period is further divided into the *Paleocene*, *Eocene*, *Oligocene*, *Miocene*, and *Pliocene* Epochs, and the Quaternary Period into the *Pleistocene* and *Holocene* Epochs). For each time period, whether an Era, Period, or Epoch, there is a corresponding geologic (rock) formation by which the time period has been dated. Rock formations constituting a specific (time) Era form a *Group* of rocks; those rocks having been formed during a specific (time) Period constitute a rock *System*; and those rock formations originating during a specific (time) Epoch are said to belong to a particular *Series* of rocks. Series of rock formations are further subdivided into *Formations*, *Stages*, etc. The following table depicts the time eras, periods, epochs, ages, and some of the more important geologic and biological changes that occurred.

(1) THE CENOZOIC ERA — 65,000,000 Years Ago to the Present

Dates	Period (System)	Epoch (Series)	Age (Stage)	Physical/Biological Features
10,000 Years Ago	QUATERNARY	HOLOCENE	(Present Time)	Continental glaciers restricted to antarctica and Greenland; extinction of giant mammals; development and spread of modern human culture.
1,800,000		PLEISTOCENE	Wisconsinan	Continental glaciers covered much of Northern North America and Northwestern Europe; volcanoes along the west coast of the U.S.; many giant mammals; appearance of modern man late in Pleistocene.
			Sangamonian	
			Illinoian	
			Yarmouthian	
			Kansan	
			Aftonian	
			Nebraskan	
			Blancan	
5,000,000	PLIOCENE	Hemphillian	Western North America uplifted; most recent uplift of Sierra Nevada, much modernization of mammals; first possible apelike humans appeared in Africa.	
22,500,000	MIOCENE	Clarendonian	Renewed uplift of Rocky Mountains and Sierra Nevada; great lava flows in Western U.S.; mammals began to acquire modern characteristics; dogs, modern type horses, manlike apes appeared.	
		Barstovian		
		Hemingfordian		
38,000,000	OLIGOCENE	Arikareean	Many older types of mammals became extinct; mastodons, first monkeys, and apes appeared.	
		Whitneyan		
		Orellan		
		Chadronian		
54,000,000	EOCENE	Duchesnean	Mountains raised in Rockies, Andes, Alps, and Himalayas; continued expansion of early mammals; primitive horses appeared.	
		Uintan		
		Bridgerian		
		Wasatchian		
65,000,000	PALEOCENE	Clarkforkian	Great development of primitive mammals	
		Tiffanian		
		Torrejonian		
		Dragonian		
		Puercan		

(2) MESOZOIC ERA — 225 Million Years Ago to 65 Million Years Ago

Dates	Period	Physical/Biological Features
65,000,000 – 136,000,000 Years Ago	CRETACEOUS	Rocky Mountains began to rise; most plants, invertebrate animals, fishes, and birds of modern types; dinosaurs reached maximum development and then became extinct; mammals small and very primitive.
136,000,000 – 190,000,000	JURASSIC	Granite foundation of Sierra Nevada laid down; conifers and cycads become dominant among plants; primitive birds appeared.

Dates	Period	Physical/Biological Features
190,000,000 – 225,000,000	TRIASSIC	Lava flows in East North America; ferns and cycads dominant among plants; modern corals appeared and some insects of modern types; great expansion of reptiles including earliest dinosaurs.

(3) PALEOZOIC ERA — 570 Million Years Ago to 225 Million Years Ago

Dates	Period		Physical/Biological Features
225,000,000 – 280,000,000 Years Ago	PERMIAN		Final folding of Appalachians and central European ranges; great glaciers in Southern Hemisphere and reefs in warm northern seas; trees of coal forests declined; ferns abundant; conifers present; first cycads and ammonites appeared; trilobites became extinct; reptiles surpassed amphibians.
280,000,000 – 320,000,000	PENNSYLVANIAN	CARBONIFEROUS	Mountains grew along east coast of North America and in central Europe; great coal swamp forests flourished in Northern Hemisphere; seed-bearing ferns abundant; cockroaches and first reptiles appeared.
320,000,000 – 345,000,000	MISSISSIPPIAN		Land plants became diversified, including many ancient kinds of trees; crinoids achieved greatest development; sharks of relatively modern types appeared; little evidence of land animals.
345,000,000 – 395,000,000	DEVONIAN		Mountains raised in New England; land plants evolved rapidly, large trees appeared; brachiopods reached maximum development; many kinds of primitive fishes; first sharks, insects, and amphibians appeared.
395,000,000 – 435,000,000	SILURIAN		Great mountains formed in northwestern Europe; first small land plants appeared; corals built reefs in far northern seas; shelled cephalopods abundant; trilobites began decline; first jawed fish appeared.
435,000,000 – 500,000,000	ORDOVICIAN		Mountains elevated in New England; volcanoes along Atlantic Coast; much limestone deposited in shallow seas; great expansion among marine invertebrate animals, all major groups present; first primitive jawless fish appeared.
500,000,000 – 570,000,000	CAMBRIAN		Shallow seas covered parts of continents; first abundant record of marine life, especially trilobites and brachiopods; other fossils rare.

(4) PRECAMBRIAN ERA — 5 Billion Years Ago to 570 Million Years Ago

Dates	Period	Physical/Biological Features
570,000,000 – 2,500,000,000 Years Ago	LATE PRECAMBRIAN (Algonkian)	Metamorphosed sedimentary rocks, lava flows, granite; history complex and obscure; first evidence of life, calcareous algae and invertebrates.
2,500,000,000 – 4,550,000,000	EARLY PRECAMBRIAN (Archean)	Crust formed on molten earth; crystalline rocks much disturbed; history unknown.

Geological Age — (Archeology) A period of time, earlier than the present postglacial period, which can only be effectively dated geologically, that is by its rock formations and fossilized matter within those rock formations.

Geological Survey — A systematic examination of an area to determine the character, relations, distribution and origin or mode of formation, of its rock masses and other natural resources.

(United States) Geological Survey (USGS) [USDI] — An agency of the U.S. Department of Interior (USDI) responsible for providing extensive earth-science studies of the nation's land, water, and mineral resources. The USGS was established by an act of Congress on March 3, 1879, to provide a permanent federal agency to conduct the systematic and scientific "classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain." An integral part of that original mission is to publish and distribute the earth-science information needed to understand, plan the use of, and manage the nation's energy, land, mineral, and water resources. Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the changing needs of the nation it serves. As part of that evolution, the USGS has become the map-making agency for the federal government, the primary source of data on surface- and ground-water resources of the nation, and the employer of the largest number of professional earth scientists. Presently, the USGS is the nation's largest earth-science agency and has the principal responsibility within the federal government for providing hydrologic information and for appraising the nation's water resources. Hydrologic data and other data are used in research and hydrologic studies to describe the quantity, quality, and location of the water resources of the United States. The collection, analysis, and interpretation of these data is done in cooperation with other federal, state and local agencies, universities, and research centers. In terms of state and regional programs, the USGS manages water information at offices located throughout the United States. Although all offices are tied together through a nation-wide computer network, each agency independently collects data and conducts studies in a particular area. Local information is best found at these sites. USGS national programs include the following (listed alphabetically):

- [1] **Branch of Quality Systems** – Part of the Office of Water Quality, this program manages and operates water-quality and quality-assurance projects for the USGS and provides training and coordination on developing quality-assurance programs for the USGS.
- [2] **Branch of Geophysical Applications and Support** – Part of the Office of Ground Water, this program provides a national focus to the regional and state water resources geophysical activities.
- [3] **Chlorofluorocarbon Laboratory** – The Reston Chlorofluorocarbon Laboratory provides analytical services for determination of the chlorofluorocarbons (CFCs) CFC-11, CFC-12, and CFC-113, sulfur hexafluoride (SF₆), and other gases in air and water samples in support of USGS hydrologic studies to trace the flow of young water (0- to 50-year time scale) and to determine the time elapsed since recharge (ground-water age).
- [4] **Drinking Water Programs** – The wide range of monitoring, assessment, and research activities conducted by the USGS is designed to help understand and protect the quality of the nation's drinking-water resources. These studies are often done in collaboration with other federal, state, tribal, and local government agencies.
- [5] **Federal-State Cooperative Water Program** – The Federal-State Cooperative Program, a partnership between the USGS and state and local government agencies, provides information that forms the foundation for many of the nation's water-resources management and planning activities.
- [6] **Ground Water Resources Program** – The Ground-Water Resources Program encompasses regional studies of ground-water systems, multidisciplinary studies of critical ground-water issues, access to ground-water data, and research and methods development. The program provides unbiased scientific information and many of the tools that are used by federal, state, and local management and regulatory agencies to make important decisions about the nation's ground-water resources.
- [7] **Ground Water Atlas of the United States** – The USGS series of print publications "The Ground Water Atlas of the United States" describes the location, the extent, and the geologic and hydrologic characteristics of the important aquifers of the nation.
- [8] **Hydrologic Instrumentation Facility (HIF)** – This facility supports USGS hydrologic data- collection activities through the identification of needs, development of technical specifications, design or development of specialized interfaces, contracts and procurements, testing and evaluation, specialized field applications, repair and calibration, quality control and assurance, and storage and distribution of hydrologic instrumentation.
- [9] **National Atmospheric Deposition Program/National Trends Network (NADP/NTN)** – A nationwide network of precipitation monitoring sites. The first sites in the network were established in 1978. The network currently consists of approximately 200 sites.
- [10] **National Irrigation Water Quality Program** – A U.S. Department of Interior program to identify and address irrigation-induced water quality and contamination problems related to Department of Interior water projects in the west.
- [11] **National Research Program** – This program conducts basic and problem oriented hydrologic research in support of the mission of the USGS. The program is designed to encourage pursuit of a diverse agenda of research topics aimed at providing new knowledge and insights into varied and complex hydrologic processes that are not well understood.
- [12] **National Streamflow Information Program** – The National Streamflow Information Program (NSIP) is a conceptual plan developed by the USGS for a new approach to the acquisition and delivery of streamflow information.
- [13] **National Stream Quality Accounting Network (NASQAN)** – This network focus is on monitoring the water quality of four of the nation's largest river systems – the Mississippi (including the Missouri and Ohio), the Columbia, the Colorado, and the Rio Grande.
- [14] **National Water Quality Assessment Program** – A program designed to assess historical, current, and future water-quality conditions in representative river basins and aquifers nationwide.
- [15] **National Water Quality Laboratory** – Fulfills analytical requirements of the USGS by analyzing environmental samples for inorganic, organic, and radiochemical constituents.
- [16] **National Water Summary** – A series of publications designed to increase public understanding of the nature,

geographic distribution, magnitude, and trends of the nation's water resources. It often is referred to as the USGS "Encyclopedia of Water."

- [17] **National Water-Use Program** — A program examining the withdrawal, use, and return flow of water on local, state, and national levels.
- [18] **State Water Resources Research Institute Program** — A matching grant program to support water resources research, education, and information transfer at the 54 university-based Water Resources Research Institutes (*Universities Water Resources Institutes*). This program includes the National Institutes for Water Resources USGS Student Internship Program.
- [19] **Toxic Substances Hydrology (Toxics) Program** — provides unbiased earth science information on the behavior of toxic substances in the nation's hydrologic environments. The information is used to avoid human exposure, to develop effective cleanup strategies, and to prevent further contamination.
- [20] **USGS Environmental Affairs Program** — This program provides guidance and information on the *National Environmental Policy Act (NEPA)* and other environmental issues.
- [21] **Water Information Coordination Program (WICP)** — The purpose of this program is to ensure the availability of water information required for effective decision-making for natural resources management and environmental protection and to do it cost effectively.
- [22] **Water, Energy, and Biogeochemical Budgets (WEBB)** — The purpose of this program is to understand the processes controlling water, energy, and biogeochemical fluxes over a range of temporal and spatial scales and to understand the interactions of these processes, including the effect of atmospheric and climatic variables.

International Programs of the USGS include primarily the development, integration, and maintenance of the Global Drainage Basins Database. In concert with the EROS Data Center, UNEP, and NASA, the USGS and these partners are developing continental drainage basins from the 30 arc second (~1-km) digital elevation models (DEM). The goals of the project are two-fold. The first goal is to produce the most realistic, verified drainage basins from the DEM. The second goal is to compare the drainage areas from the 30 arc second (~1-km) source to existing basin sources. A comparative analysis of what drainage source produces the best physical boundary will benefit researchers, scientists, and individuals that use hydrological feature data for modeling, calculating, and assessing environmental problems. The USGS is organized into three operational Divisions: the National Mapping Division (NMD), charged with development and application of mapping and *Geographic Information System (GIS)* technology; the Geologic Division (GD), which conducts geologic mapping and research; and the Water Resources Division (WRD). The mission of the Water Resources Division of the USGS is to provide the hydrologic information and understanding needed to manage the nation's water resources to benefit its residents. Typical water resource programs sponsored by the WRD include:

- [1] Data collection to aid in evaluating the quantity, quality, distribution, and use of the nation's water resources;
- [2] Analytical and interpretive water-resources appraisals to describe the occurrence, quality, and availability of surface and groundwater throughout the nation;
- [3] Basic and problem-oriented research in hydraulics, hydrology, and related fields of science and engineering;
- [4] Scientific and technical assistance in hydrology to other federal, state, and local agencies;
- [5] Development and maintenance of national computer data bases and associated Geographic Information Systems (GIS) of hydrologic data — streamflow, water quality and biology, groundwater characteristics, and water use; and
- [6] Public distribution of water-resources data and results of water-resources investigations through reports, maps, computerized information services, and other forms of release.

Programs of the Water Resources Division are funded under three types of arrangements:

- [1] **Federal Program** — funding is appropriated directly to USGS by the U.S. Congress for projects of national interest;
- [2] **Cooperative Program** — funding is shared by USGS and interested state and local agencies; and
- [3] **Other Federal Agencies (OFA) Program** — funding is supplied by federal agencies requesting technical assistance from the USGS.

The Water Resources Division's headquarters is at the USGS National Center in Reston, Virginia. Regional offices are maintained in Reston; Atlanta, Georgia; Denver, Colorado; and Menlo Park, California. With the exception of the National Research Program (NRP) centers at Reston, Denver, and Menlo Park, most of the WRD program is distributed to 51 USGS District Offices organized by state boundaries.

Geology — (1) The science that studies the physical nature and history of the earth. (2) Science dealing with the origin, history, material, and structure of the earth, together with the forces and processes now operating to produce changes on the earth's surface and within it.

Geomorphic Surface — A mappable area of the land surface formed during a defined time period by deposition or erosion (or both, in different parts) of at least a thickness of material sufficient to accommodate a pedogenic soil. Its age (i.e., period of formation) ordinarily is defined by relations to other geomorphic surfaces, or by the soils or sediments that form or underlie the surface.

Geomorphology (Geomorphic) — (1) The study of the characteristics, origin and development of land forms. (2) That branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of land forms. The term usually applies to the origins and dynamic morphology (changing structure and form) of the earth's land surfaces, but it can also include the morphology of the sea floor and the analysis of extraterrestrial terrains. Sometimes included in the field of physical geography, geomorphology is really the geological aspect of the visible landscape. Also see *Geomorphology, Historical*, and *Geomorphology, Process*.

Geomorphology, Historical — Historical geomorphology represents one branch of *Geomorphology* which provides the means to

analyze the long-term change in landforms through the concept of cyclic change. The concepts evolved at the turn of the 20th century and were put forward by the American geologist William Morris Davis. The theory stated that every landform could be analyzed in terms of structure, process, and stage. Structure and process are treated by the science of geomorphology. However, the concept of stage introduced the element of time, and is subject to a far greater degree of interpretation. As postulated by Davis, every landform underwent development through a predictable, cyclic sequence: i.e., youth, maturity, and old age. Historical geomorphology relies on various chronological analyses, notably those provided by stratigraphic studies of the last 2 million years, known as the *Quaternary Period*. The relative chronology usually may be worked out by observation of stratigraphic relationships, with the time intervals involved established more precisely by dating methods such as historical records, radiocarbon analysis, tree-ring counting (*Dendrochronology*), and paleomagnetic studies. By applying such methods to stratigraphic data, a quantitative chronology of events is constructed that provides a means for calculating long-term rates of change. Also see *Geomorphology, Process*.

Geomorphology, Process — The second branch of *Geomorphology*, process geomorphology analyzes contemporary dynamic processes at work in landscapes. The mechanisms involved are weathering and erosion and combine processes that are in some respects destructive and in others constructive. The bedrock and soil provide the passive material, whereas the climatic regime and crustal dynamics together provide the principal active variables. Also see *Geomorphology, Historical*.

Geophysical Log — A record of the structure and composition of the earth encountered when drilling a well or similar type of test or boring hole.

Geophysical Logging — A technique that measures a physical, chemical, or radioactive property of the subsurface, either characteristic of the formation fluid or of the formation in which the fluid occurs, such as resistivity and self-potential logging (electric logging), gamma and neutron logging (radiation logging), caliper logging, temperature logging, and photographic logging.

Geophysics (also Geophysical) — (1) The study of the physical characteristics and properties of the earth, including geodesy, seismology, meteorology, oceanography, atmospheric electricity, terrestrial magnetism, and tidal phenomena. (2) The science of the physics of the earth. Deals with the structure, composition, and development of the earth and makes use of geodesy, seismology, meteorology, oceanography, magnetism, and other earth sciences. Applied geophysics deals mainly with geologic exploration or prospecting using the instruments and applying the methods of physics and engineering.

Geoponics — The art or science of cultivating the earth; husbandry.

Geopressured Reservoir — A geothermal reservoir consisting of porous sands containing water or brine at high temperature or pressure.

Geosol — (Geography) A stratigraphic unit of distinctive material, laterally traceable.

Geostatic — Capable of sustaining the pressure of the weight of overlying earth materials.

Geotectonics — See *Tectonics*.

Geothermal — (1) Of or pertaining to the heat of the interior of the earth. (2) Terrestrial heat, usually associated with water as around hot springs.

Geothermal Energy — The heat energy available in the earth's subsurface, extracted from three basic sources: (1) steam; (2) hot water; and (3) hot rocks or near surface intrusions of volcanic molten rock. The normal thermal gradient of the earth's crust is such that the temperature in a deep well or mine typically increases by about 1°F (0.56°C) for each 100 feet of depth.

Geothermal Gradient — The rate of increase of temperature of the earth with depth. The geothermal gradient away from active volcanic areas averages 300 degrees Centigrade per kilometer. The average heat flow at the surface of the earth is 1.25×10^{-6} calories per square centimeter per second.

Geothermics — The science pertaining to the earth's interior heat. Its main practical application is in finding natural concentrations of hot water, the source of *Geothermal Energy*, for use in electric power generation and direct heat applications such as space heating and industrial drying processes. Heat is produced within the crust and upper mantle of the earth primarily by decay of radioactive elements. This geothermal energy is transferred to the earth's surface by diffusion and by convection movement of magma (molten rock) and deep-lying circulating water. Surface hydrothermal manifestations include hot springs, geysers, and *Fumaroles*.

Germicide — A substance formulated to kill germs or microorganisms. The germicidal properties of chlorine make it an effective disinfectant.

Geyser — (1) A natural hot spring or fountain that periodically discharges a column of hot water and steam into the air. (2) An orifice that erupts boiling water and steam intermittently. (3) A periodic thermal spring that results from the expansive force of super heated steam. Also, a special type of thermal spring which intermittently ejects a column of water and steam into the air with considerable force.

GFD — Gallons per square foot of membrane per day; the flux for reverse osmosis membranes.

Giardia — Microscopic organisms that, when ingested, can result in diarrhea, fever and other gastrointestinal symptoms. They are naturally present in bodies of water throughout the world.

Giardia lamblia — (1) Flagellate protozoan which may be shed during its cyst stage in the feces of man and other warm blooded animals. When water containing these cysts is ingested, the protozoan may cause a gastrointestinal disease called *Giardiasis*. (2) A flagellate protozoan that causes the severe gastrointestinal illness *Giardiasis*, when it contaminates drinking water.

Giardiasis — A disease that results from an infection by the protozoan parasite *Giardia Intestinalis* (*Giardia* flagellates) caused by drinking water that is either not filtered or not chlorinated. The disorder is more prevalent in children than in adults and is characterized by abdominal discomfort, nausea, and alternating constipation and diarrhea.

Gigawatt Hour (GWh) — One billion *Watt-hours* (Wh).

Gill — (1) A unit of volume or capacity in the U.S. Customary System, used in liquid measure, equal to $\frac{1}{4}$ of a pint or four ounces (118 milliliters). (2) A unit of volume or capacity, used in dry and liquid measure, equal to $\frac{1}{4}$ of a British Imperial pint (142

milliliters).

GIS — See *Geographical Information System (GIS)*.

Glacial — (1) Characterized or dominated by the existence of *Glaciers*. Used of a geologic or *Glacial Epoch* period of time, i.e., the *Pleistocene Epoch*. (2) Extremely cold; icy. (3) Having the appearance of ice. (4) Describing the action, features, movements, and materials produced by or derived from glaciers or ice, or a region covered by glaciers or ice. (5) Describing a *Geologic Time Period* marked by an ice age. (6) (Chemistry) Of, relating to, or tending to form into ice-like crystals.

Glacial Action — The resultant effects caused by the movement of a *Glacier*. Also see *Glacial Till*, *Glaciofluvial Deposits*, *Moraines*, *Lateral Moraines*, and *Terminal Moraines*.

Glacial Drift — (1) Sediment in transport in glaciers or deposited by glaciers. (2) A general term for unconsolidated sediment transported by glaciers and deposited directly on land or in the sea. (3) All earth material transported and deposited by the ice and/or by water flowing from a glacier. It consists of rock flour, sand, pebbles, cobbles, and boulders, and may occur in a heterogeneous mass or be reasonably well sorted, depending on the manner of deposition.

Glacial Epochs — (Geology) Any of those parts of geological time, from Pre-Cambrian time onward in both the Northern and Southern hemispheres, during which a much larger portion of the earth was covered by glaciers than at present. More specifically refers to the latest of the glacial epochs, that of the Quaternary period, known as the *Pleistocene Epoch*, beginning some 3 million years ago, during which Canada, northern and northeastern U.S., northern and northwestern Europe, and northern Asia, together with most high mountain regions in the Northern Hemisphere were largely covered with ice. It has been divided into a number of stages. Those recognized for the interior of North America are, in order of age: *Jerseyan* or *Nebraskan* (glacial); *Aftonian* (interglacial); *Kansan* (glacial); *Yarmouth* and *Buchanan* (interglacial); *Illinoian* (glacial); *Sangamon* (interglacial); *Iowan* (glacial); *Peorian* (interglacial); *Earlier Wisconsin* (glacial); an unnamed (interglacial) interval; *Later Wisconsin* (glacial); *Champlain* (glaciolacustrine epoch).

Glacier Fluctuations (Geoindicator) [GCRIO] — Glaciers are highly sensitive, natural, large-scale, representative indicators of the energy balance at the Earth's surface in polar regions and high-altitudes. Their capacity to store water for extended periods exerts significant control on the surface *Water Cycle (Hydrologic Cycle)*. The advance and retreat of mountain glaciers creates hazards to nearby human structures and communities through avalanches, slope failure, catastrophic outburst floods from ice and moraine-dammed lakes. Notwithstanding local glacier advances, the length of mountain glaciers and their ice volume has decreased throughout the world during the past century or two, providing strong evidence for climate warming, though there may also be local correlations with decreasing precipitation. It is estimated that the European Alps have lost more than half their ice in the past century. Changes in glacier movement, length and volume can exert profound effects on the surrounding environment, for example through sudden melting which can generate catastrophic floods, or surges that trigger rapid advances. Standard parameters include mass balance and the glacier length, which determines the position of the terminus. The location of the terminus and lateral margins of ice and rock glaciers exerts a powerful influence on nearby physical and biological processes. Through a combination of specific balance, cumulative specific balance, accumulation area ratio and equilibrium-line altitude, mass balance reflects the annual difference between net gains (accumulation) and losses (ablation). It may also be important to track changes in the discharge of water from the glacier as indicators of glacier hydrology. Abrupt changes may warn of impending acceleration in melting, cavitation, or destructive flooding. See *Geoindicators (U.S. Global Change Research Information Office)*.

Glacial Lake — A lake whose water is derived primarily from glacial melting, or such a lake occupying a basin produced by glacial erosion or deposition. Also referred to as a *Glacier Lake*.

Glacial Lobe — A large, tongue-shaped mass of ice that projects from the edge of the main mass of an ice sheet or ice cap.

Glacial Outwash — Stratified material, chiefly sand and gravel deposited by meltwater streams in front of the margin of a glacier.

Glacial Period — (Geology) (1) The period of time encompassing the *Glacial Epochs*. (2) An interval of geologic time characterized by one or more major advances of ice.

Glacial Recession or Glacial Retreat — See *Recession*.

Glacial Scour — (Geology) A natural process in which bedrock is abraded, scratched, and polished, and surficial material removed by rock fragments is carried by or embedded in a moving glacier.

Glacial Scratch — See *Glacial Striation*.

Glacial Stairway — See *Cascade*.

Glacial Striation — (Geology) A series of long, fine, generally straight, parallel scratches that are inscribed on a rock surface by the continuing abrasive action of rock fragments embedded in a moving glacier. Also referred to as *Glacial Scratch*.

Glacial Till — Till is the mixture of rocks, boulders, and soil picked up by a moving glacier and carried along the path of the ice advance. The glacier deposits this till along its path — on the sides of the ice sheet, at the toe of the glacier when it recedes, and across valley floors when the ice sheet melts. These till deposits are akin to the footprint of a glacier and are used to track the movement of glaciers. These till deposits can be good sources of groundwater, if they do not contain significant amounts of impermeable clays. Also see *Moraines*, *Lateral Moraines*, and *Terminal Moraines*.

Glaciate, also Glaciation — (1) Alteration of the earth's solid surface through erosion and deposition by glacier ice. (2) To cover with ice or a *Glacier*; to subject to or affect by *Glacial Action*. (3) To freeze.

Glaciated Terrain — (Geology) A land surface formerly covered and modified by a glacier or ice sheet, and exhibiting glaciation marks and glaciation features.

Glaciated Valley — A *U-Shaped Valley* formerly occupied by a *Glacier*.

Glaciation — (Geology) The covering and alteration of the Earth's surface by glaciers, including erosion, deposition, planing, polishing of rocks, releveling, change of drainage system, and creation of numerous lakes.

Glaciation Limit — (Geophysics) The lowest altitude in a given location in which a glacier can form.

Glacier — (1) A huge mass of ice, formed on land by the compaction and recrystallization of snow, that moves very slowly downslope or outward due to its own weight. (2) Bodies of land ice that consist of recrystallized snow accumulated on the surface of the ground, and that move slowly downslope.

Glacier Burst — A sudden release of a reservoir of water that has been impounded within or by a glacier.

Glacier Dammed Lake — The lake formed when a glacier flows across the mouth of an adjoining valley and forms an ice dam.

Glacier Flow — The slow downward or outward motion of a glacier as a result of gravitational force. Also referred to as *Ice Flow*.

Glacier Front — The leading margin of a *Glacier*.

Glacier Ice — Any ice that is or once was part of a glacier.

Glacier Lake — A lake formed by the obstruction of natural drainage by the edge of a glacier or ice sheet. Also referred to as a *Glacial Lake*.

Glacier Meal — Finely ground rock particles produced by glacial abrasion. Also referred to as *Rock Flour*.

Glacier Remanié — A *Glacier* formed by the regelation of ice blocks that have accumulated as a result of avalanches and icefalls from glaciers at higher levels.

Glacier Table — A stone slab supported over the surface of a mountain glacier by a column or columns of ice.

Glacioeustasy — (1) The condition in which massive ice sheets store considerable quantities of water. Generally refers to periods of time during the Wisconsin age of the *Pleistocene (glacial) Epoch*, when the oceans were some 300 to 330 feet lower than today and these waters were stored in the massive glaciers of this Ice Age period. (2) Changes in sea level due to storage or release of water on land as snow and glacier ice. Also see *Glacioeustasy*.

Glacioeustasy — (Oceanography) The state of hydrologic equilibrium between world moisture transport to the continents in the form of snow or freezing rain and to the oceans as meltwater; an example of the significance of glacioeustatic change is the drop in world sea level during the most recent ice ages: between 15,000 and 18,000 years ago, sea level was more than 100 meters lower than it is today, and 40,000 years ago it may have been more than 150 meters lower than today. Also see *Glacioeustasy*.

Glaciofluvial — Pertaining to the meltwater streams flowing from wasting glacier ice and especially to the deposits and landforms produced by such streams.

Glaciofluvial Deposits — Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. Also see *Glacial Action*, *Glacial Drift* and *Glacial Till*.

Glaciolacustrine — (Geology) (1) Derived from or related to glacial lakes or the material that is deposited into such lakes, especially deposits such as kame deltas. (2) Pertaining to, or characterized by, glacial and lacustrine processes or conditions applied especially to deposits made in lakes.

Glaciology — (1) The study of all processes related to any form of existing solid water, including snow and ice. (2) Collectively, the branches of science concerned with the causes and modes of ice accumulation and with ice action, on the earth's surface. Specifically, the branch of geology which studies the effects of glacial epochs, glaciation, and ice in modifying the earth's surface and in affecting the life and distribution of plants and animals.

Glacon — (Oceanography) A piece of sea ice larger than brash but less than 1 kilometer across.

Glade — An open, spacious *Wetland*, as in the *Everglades*.

Glare Ice — Any smooth, shiny, highly reflective sheet of ice.

Glauber's Salt — A colorless crystalline salt composed of sodium sulphate decahydrate ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$).

Glaucinite — A greenish clay mineral, a hydrous silicate of potassium, iron, aluminum, or magnesium, $(\text{K},\text{Na})(\text{Al},\text{Fe},\text{Mg})_2(\text{Al},\text{Si})_4\text{O}_{10}(\text{OH})_2$, found in greensand and used as a fertilizer and water softener.

Glaze — (1) A thin, glassy coating of ice that forms when a light rain condenses on a surface whose temperature is below freezing. Also referred to as *Black Ice*. (2) A coating of ice, generally clear and smooth but usually containing some air pockets, formed on exposed objects by the freezing of a film of supercooled liquid water deposited by rain, drizzle, or fog. (3) Homogeneous, transparent ice layers which are built up, either from supercooled rain or drizzle, or from rain or drizzle, when the surfaces on which it forms are at temperatures of 32°F (0°C) or lower. Glaze often forms a matrix for sleet pellets that fall at the same time.

Glime — A coating of ice having a consistency between that of *Glaze* and *Rime*.

Glimmer Ice — Ice that forms within the cracks or on the puddles of old ice.

Glob — A small drop; a globule.

(United States) Global Change Research Information Office (GCRIO) — The United States Global Change Research Information Office (GCRIO) provides access to data and information on global environmental change research, adaptation/mitigation strategies and technologies, and global change related educational resources on behalf of the U.S. Global Change Research Program (USGCRP) and its participating U.S. federal agencies and organizations. GCRIO is implemented by The Center for International Earth Science Information Network (CIESIN) at Columbia University. Global change research brings significant benefits to the nation and the world by providing a well-founded scientific understanding of the Earth system to ensure the availability of future resources essential for human well-being, including water, food, fiber, ecosystems, and human health. The Global Change Research Program, working with research institutions within the U.S. and internationally, provides the foundation for increasing the skill of predictions of seasonal-to-interannual climate fluctuations (which can bring excessively wet and dry periods) and long-term climate change. The USGCRP also sponsors research to understand the vulnerabilities to changes in important environmental factors, including changes in climate, ultraviolet (UV) radiation at the Earth's surface, and land cover. Scientific knowledge is essential for informed decision making on environmental issues and to ensure the social and economic health of future generations. Thus global change research is a critical investment for the future of this nation, its economy, and the health and safety of its citizens. The USGCRP was created as a Presidential Initiative in 1989 and formalized in 1990 by the Global Change Research Act of 1990. Since that time, global change research has remained a key science initiative. Continuing to improve scientific understanding of the Earth system is a priority of the National Science and Technology Council's

Committee on Environment and Natural Resources. One of the most significant developments of the program has been the creation of *Geoindicators*. These indicators or measures of environmental change are used to monitor and assess changes in fluvial, coastal, desert, mountain and other terrestrial areas and provide important baseline measures against which human-induced and natural environmental stresses can be better understood. The U.S. Global Change Research Program integrates research carried out under the auspices of a number of federal agencies of the U.S. government. The following federal agencies participate in the Global Change Research Program:

- [1] Department of Agriculture;
- [2] Department of Commerce, National Oceanic and Atmospheric Administration (NOAA);
- [3] Department of Defense;
- [4] Department of Energy;
- [5] Department of Health and Human Services, National Institutes of Health (NIH);
- [6] Department of the Interior, U.S. Geological Survey (USGS);
- [7] Environmental Protection Agency (EPA);
- [8] National Aeronautics and Space Administration (NASA);
- [9] National Science Foundation (NSF); and
- [10] Smithsonian Institution

For additional information on specific water-related Geoindicators presented in this publication, see *Coral Chemistry and Growth Patterns*, *Glacier Fluctuations*, *Groundwater Chemistry in the Unsaturated Zone*, *Groundwater Level*, *Groundwater Quality*, *Karst Activity*, *Lake Levels and Salinity*, *Sediment Sequence and Composition*, *Soil and Sediment Erosion*, *Soil Quality*, *Stream Channel Morphology*, *Stream Sediment Storage and Load*, *Streamflow*, *Surface Water Quality*, *Wetlands Extent*, *Structure and Hydrology*. The U.S. Global Change Research Program Office is located at 400 Virginia Avenue, SW, Suite 750, Washington, D.C. 20024. Telephone: (202) 488-8630; Fax: (202) 488-8681; E-mail: information@usgcrp.gov; Web site: <http://www.usgcrp.gov> and <http://www.globalchange.gov>.

Global Positioning System (GPS) — A system which verifies latitude and longitude of a location on the ground through the use of a transmitter and a remote (satellite) vehicle.

Global Sea — (Oceanography) All the seawater of the earth thought of as one ocean undergoing constant mixing.

Global Temperature Change — The net result of four primary factors including the *Greenhouse Effect*, changes in incoming solar radiation, altered patterns of ocean circulations, and changes in continental position, topography and/or vegetation patterns and extent. Three feedback mechanisms which affect global temperature change include: (1) cloud height and amount; (2) snow and ice distribution; and (3) atmospheric water vapor levels.

Globigerina Ooze — (Oceanography) A calcareous, deep-ocean sediment composed of at least 30 percent skeletal remains of foraminifera, predominantly of the genus *Globigerina*.

Globule — A tiny ball or globe, especially a drop of liquid.

Gobbet — A small amount of liquid; a drop.

“Goodness of Fit” — (Statistics) Generally speaking, a “good” econometric model is one which helps to explain or account for a large proportion of the variance in the dependent variable. Large residuals, or unexplained variations, imply a poor fit, while small residuals imply a good fit. As a more precise measure of this goodness of fit, a *Coefficient of Determination*, R^2 , is used which measures the proportion of the total variation in the dependent variable explained by the variations in the independent variable(s). Also see *Criteria Testing*.

Gooseneck — A portion of a water service connection between the distribution system water main and a meter. Sometimes referred to a *Pigtail*.

Gore-Tex — A trademark used for a water-repellant, breathable laminated fabric used primarily in outerwear and shoes.

Gorge — (1) (Geography) A deep, usually narrow canyon. (2) (Oceanography) An obstruction in a channel, river, or sea canyon, consisting of ice, rock, sediment, or plant material.

GPCD — Gallons per capita (per person) per day – a measure of water use in municipalities.

GPD (gpd) — Gallons per day, a measure of the rate of flow or the rate of water withdrawal from a well. Typically used when the rate of flow in cubic feet per second (cfs) is too low to be useful.

GPM (gpm) — Gallons per minute.

Grab Sample — (1) A single sample collected at a particular time and place which represents the composition of the water only at that time and place. (2) Typically, a single water or air sample drawn over a short time period. As a result, the sample is not representative of long-term conditions at the sampling site. This type of sampling yields data that provides a snapshot of conditions or concentrations at a particular point in time.

Graben — (Geology) (1) A depressed tract bounded on at least two sides by faults and generally of considerable length as compared to its width. (2) A rather steeply sided valley formed when faulting caused a block-shaped area to drop relative to the surrounding terrain. Lake Tahoe, situated on the border between the states of California and Nevada, occupies a graben.

Grade — (Hydraulics) (1) The slope of a stream bed. More specifically, the longitudinal profile of a stream. (2) The elevation of the invert of the bottom of a pipeline, canal, culvert or similar conduit. (3) The inclination or slope of a pipeline, conduit, stream channel, or natural ground surface; usually expressed in terms of the ratio or percentage of number of units of vertical rise or fall per unit of horizontal distance. A 0.5 percent grade would be a drop of one-half foot per hundred feet of pipe.

Grade-Control Structure — A weir, dam, sill, drop structure, or other structure used to control erosion in stream channels with steep grades or where the slope has been destabilized.

Grade Level — The level attained by a stream when its longitudinal profile is a straight line, indicating its entire course has been reduced to a uniform gradient.

- Graded** — An engineering term pertaining to a soil or an unconsolidated sediment consisting of particles of several or many sizes or having a uniform or equable distribution of particles from coarse to fine.
- Graded Profile** — See *Profile of Equilibrium*.
- Graded Reach** — (1) Any part of a stream where erosion and deposition are in equilibrium. (2) Any reach of a *Graded Stream*.
- Graded Stream** — A stream in which, over a period of years, the slope is delicately adjusted to provide, with available discharge and with prevailing channel characteristics, just the velocity required for transportation of the sediment load supplied from the drainage basin. Also, a stream in which most irregularities, such as waterfalls and cascades, are absent. Streams tend to cut their channels lower at a very slow rate after they become graded.
- Grade Stabilization Structure** — A structure for the purpose of stabilizing the grade of a gully or other watercourse, thereby preventing further head-cutting or lowering of the channel grade.
- Gradient** — (1) Degree of incline, as the slope of a stream bed. The slope of a river expressed in vertical feet of decline per mile of river length. The vertical distance that water falls while traveling a horizontal distance downstream. (2) Change in value of one variable with respect to another variable, i.e., geothermal gradient, change in temperature with depth. Also see *Hydraulic Gradient* and *Temperature Gradient*.
- Gradually Varied Flow** — (Hydraulics) Non-uniform flow in which depth of flow changes gradually through a reach. Typical of normal natural valley and channel flow, which can be either steady or unsteady flows.
- Grain** — A unit of weight equivalent to 1/7000th pound. The hardness of water is sometimes expressed in units of grains per gallon. Also see *Avoirdupois Weight*.
- Grain per Gallon (gpg)** — A common basis for reporting water analyses in the water-treatment industry in the United States and Canada. One grain per U.S. gallon equals 17.12 milligrams per liter.
- Gram** — (1) A unit of mass equivalent to one milliliter of water at 4 degrees Celsius. Also, 1/454 of a pound. (2) The basic unit of weight in the *Metric System* equal to 1/1000 kilogram and nearly equal to the mass of one cubic centimeter of water at its maximum density; also equal to 1/28th of an ounce or 0.0022046 pound.
- Graminoid** — A grass or grass-like plant.
- Gram Molecular Weight (GMW)** — The mass, in grams, of a substance equal to its molecular weight. For example, the molecular weight of water (H₂O) is 18 (the sum of the atomic weights of two hydrogen atoms and one oxygen atom), so its gram molecular weight is 18 grams. The amount of a material equal to its gram molecular weight comprises one gram-mole of the substance.
- Granite** — (Geology) A light-colored plutonic igneous rock made up of interlocking grains of glassy or milky quartz, white or pink feldspar, and specks of dark mica or hornblende. The Sierra Nevada Mountains (California and Nevada) are made up of granite and similar rock types.
- Granular Activated Carbon (GAC)** — In water treatment, granular activated carbon has been used mainly for taste and odor control, with some special applications that remove *Synthetic Organic Chemicals (SOCs)* or *Volatile Organic Chemicals (VOCs)* from contaminated water. Two basic forms of GAC are typically used: (1) a coal-based carbon manufactured as an adsorbent; and (2) a wood-based carbon manufactured primarily as a substrate for biological activity. Also see *Biological Activated Carbon (BAC) Process*.
- Granular Activated Carbon Treatment (GACT)** — A filtering system often used in small water systems and individual homes to remove organics. This process can also be highly effective in removing elevated levels of radon from water.
- Granular Ice** — Ice composed of small, opaque, irregularly shaped crystals that resemble grains of sand.
- Grapevine Drainage Pattern** — See *Trellis Drainage Pattern*.
- Grass/Forb** — An early forest successional stage where grasses and forbs are the dominant vegetation.
- Grassed Waterway or Outlet** — A natural or constructed waterway, usually broad and shallow and covered with erosion-resistant grasses, suitable to resist potential damages resulting from runoff.
- Grassland** — (Ecology) (1) An area of natural vegetation dominated by grasses; an area where there is enough moisture to support grass, but not enough to support trees. Such areas are often called *Steppes* or *Prairies* in temperate regions and *Savannahs* in tropical regions. (2) An area, such as a prairie or meadow, of grass or grasslike vegetation. More specifically, grasslands constitute a geographical region dominated by shrubs and grasses, receiving 10 to 30 inches of rain annually. *Alpine Grasslands* are in cool, high-elevation areas. *Temperate Grasslands*, called *Prairie* (North America), *Pampas* (South America), *Steppe*, (Asia), or *Veldt* (South Africa), are found in regions with moderate temperatures. *Tropical Grasslands*, also called *Savannas*, are found in warmer climates. Also see *Biome*.
- Graupel** — A snow or ice crystal heavily coated with *Rime*. See *Snow Pellets*.
- Gravel** — (1) Small stones and pebbles or a mixture of sand and small stones. (2) Loose, rounded fragments of rock or mineral pieces larger than 2 mm in diameter. (3) A mixture composed primarily of rock fragments 2 mm (0.08 inch) to 7.6 cm (3 inches) in diameter. Usually contains much sand.
- Gravel Envelope** — In well construction, a several-inch thickness of uniform gravel poured into the annular space between the well casing and the drilled hole. Also referred to as *Gravel Pack*.
- Gravel-Packed Well** — A well in which filter material is placed in the annular space to help prevent fine-grain sediments from entering the well and to stabilize the sediments around the well screen.
- Gravimetric** — A means of measuring unknown concentrations of water quality indicators in a sample by weighing a precipitate or residue of the sample.
- Gravitational Head** — Component of total *Hydraulic Head* related to the position of a given mass of water relative to an arbitrary datum.
- Gravitational Water** — (1) Water that moves into, through, or out of a soil or rock mass under the influence of gravity. (2) Subsurface water in excess of absorption water and pellicular water (film adhering to soil particles) which responds to the force of gravity and therefore percolates downward toward the water table. See *Free Water*.

Gravity Dam — (1) A dam constructed of concrete and/or masonry that relies on its weight for stability. (2) A concrete structure proportioned so that its own weight provides the major resistance to the forces exerted on it. Also see *Dam*.

Gravity Drainage — The removal or withdrawal of water from soil layers as a result of gravitational force.

Gravity Flow — (1) The downhill flow of water through a system of pipes, generated by the force of gravity. (2) Water or wastewater flowing from a higher elevation to a lower elevation due to the force of gravity. The water does not flow due to energy provided by a pump. Wherever possible, wastewater collection systems are designed to use the force of gravity to convey waste liquids and solids. (3) The movement of ice in a *Glacier* resulting from the steepness of the slope on which the glacier rests. Also see *Glacier Flow*.

Gravity Irrigation — (1) Irrigation in which the water is not pumped but flows and is distributed by gravity, and includes sprinkler systems when gravity furnishes the desired head (pressure). (2) Irrigation method that applies irrigation water to fields by letting it flow from a higher level supply canal through ditches or furrows to fields at a lower level.

Gravity (Surface) Irrigation Systems — Gravity irrigation systems include any number of systems in which gravity is the primary method of uniformly distributing the water to the soil surface. The principle types of gravity systems include:

- [1] **Furrow Systems** – Most common gravity system, and is used for field crops, truck crops, trees, and vines. Consists of channels or corrugations cut or pressed into the soil of a field, usually one furrow between planted rows of crops with a slight grade from the head of the field where water enters the furrows to the bottom of the field where tailwaters are recovered or drained away. Water is delivered to the furrows using an earthen ditch and siphon tubes, gated pipe, or underground piping and above ground valves.
- [2] **Border-Strip Systems** – A system typically used for alfalfa and pasture lands, but can also be used on field crops and trees and vines. A field is divided into a number of strips, usually between 20 to 100 feet wide. Low levees or borders divide each strip with water delivered to each strip using an earthen ditch and siphon tubes, gated pipe, or underground piping and above ground valves.
- [3] **Level Basin Systems** – A system used on alfalfa, pasture, trees, vines, and field crops. The size of each basin is variable and depends upon soil infiltration rate and flow rate of water. Earthen berms are built up on all sides of the basin with each basin having little or no slope. Water is delivered into each basin from pipelines and valves for smaller basins or from lined or unlined ditches with large gates.

Gravity Spring — A spring that flows in response to the pull of gravity from a point where the land intersects the *Water Table*.

Gravity Water — Water in a canal or pipeline that is delivered by gravity, rather than by pumping. Also see *Free Water*.

Gravity Wave — (1) Fluid Mechanics) A wave in a fluid medium whose principal restoring force is due to gravitational effects rather than compressional effects. (2) (Oceanography) A water wave form whose velocity of propagation is controlled primarily by gravity; all waves over 2 cm in length are gravity waves, while those under 2 cm are capillary waves.

Graywater (Gray Water or Greywater) — (1) Wastewater other than sewage, such as sink drainage or washing machine discharge. (2) Waste water from a household or small commercial establishment which specifically excludes water from a toilet, kitchen sink, dishwasher, or water used for washing diapers. More commonly spelled *Greywater*. Contrast with *Black Water*.

Grazing — The consumption by livestock and wildlife of range or pasture forage. Although strictly grazing refers to consumption of *Forbs* (i.e., an *Herbaceous* plant other than a *Graminoid*) and graminoids (i.e., grass or grass-like plants), it is often used in a general sense to include both grazing and browsing.

Grease — (Wastewater Treatment) In a collection system, grease is considered to be the residues of fats, detergents, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other nonfatty materials which tend to separate from water and coagulate as floatables or scums.

Grease Buildup — (Wastewater Treatment) Any point in a wastewater collection system where coagulated and solidified greases accumulate and build up. Many varieties of grease have high adhesive characteristics and collect other solids, forming restrictions and stoppages in collection systems.

Grease Ice — A slushy layer of ice recently formed by the thickening of frazil on the surface of a body of water, especially on the ocean. Also referred to as *Ice Slush*.

Grease Trap — (Wastewater Treatment) A receptacle designed to collect and retain grease and fatty substances usually found in kitchens or from similar wastes. It is installed in the drainage system between the kitchen or other point of production of the waste and the building wastewater collection line. Commonly used to control grease from restaurants.

Great Basin — A vast Intermountain region which was first recognized for its unique geophysical structure as early as 1846 by John C. Frémont, who fittingly named it the “Great Basin”. The hydrographic Great Basin is defined as an area of internal drainage systems bordered by the Rocky Mountains on the east, the Sierra Nevada on the west, the Columbia Plateau on the north and the Colorado Plateau on the south. Surface waters within this expansive area never reach the ocean, but are confined to closed basins which ultimately drain to terminal lakes, playas, wetlands, or sinks. The Great Basin covers an area of approximately 205,780 square miles (131,699,230 acres or 532,970 square kilometers) and includes nearly all of Nevada, much of eastern California, western Utah, southeastern Oregon, and portions of southern Idaho. The Great Basin is characterized by considerable variation in its topography, with one record example for adjacent valley bottoms and mountain tops being the vertical relief of 11,331 feet between Badwater in Death Valley (282 feet below mean sea level, or MSL) and nearby Telescope Peak in the Panamint Range (11,049 feet MSL). The most extreme example of this variable topography within the Great Basin is the elevation difference of 14,744 feet MSL over a distance of 84 miles which separates Death Valley’s Badwater site from the summit of Mount Whitney (14,462 feet MSL). More typically, the difference between the Great Basin’s mountaintops and valley bottoms ranges from 3,800 feet to 7,600 feet with an average difference of 5,800 feet. The extreme topographic relief of this area greatly affects the distribution of plants and animals and provides niches for a multitude of organisms with diverse habitat requirements.

- [1] **Biological Diversity** – The Great Basin is a land of striking contrasts containing considerable biological diversity.

The Great Basin ranks as the fourth highest in terms of the number of vascular plant species among 116 ecoregions throughout North America and also ranks very high in the number of species of birds, butterflies and mammals. This high biological diversity is produced by a blending of the surrounding ecoregions' flora and fauna populations with the unique species of the Great Basin and diverse habitats found within the Great Basin's "basin and range" topography. The Great Basin is home to the oldest living organisms on earth, such as the Great Basin bristlecone pines, which can live up to 4,900 years, and the creosotebush clones in the Mojave Desert, which are estimated to be 10,000-11,000 years old.

- [2] **Landforms** – The landforms of the Great Basin define the region as part of the basin and range physiographic province which, in addition to characterizing much of northern and central Nevada, also extends south to include the Sonoran Desert and Chihuahuan Desert of Arizona and Mexico. This region is characterized by hundreds of long, narrow, and roughly parallel, north-south oriented mountain ranges that are separated by deep, sediment-filled valleys. The Great Basin's mountains are geologically recent, and the landforms are a product of the formation and erosion of the Rocky Mountains and the Sierra Nevada. The structure of the more than 400 mountain ranges in the region are similar; however, their compositions are diverse and range from granite ranges in the western portion of the Great Basin, basalt ranges in the northwest, rhyolite mountains throughout the center, and limestone mountains dominating the east and southwest.
- [3] **Topography** – The Great Basin's topographic extremes, particularly along its eastern and western mountain borders, provides for relatively abrupt ecological and biological 'transition zones', which represent areas of contact between the flora and fauna populations of two adjoining regions. These zones of habitat transition retain characteristics of both regions to varying degrees and also create their own unique habitat conditions. The Great Basin's eastern boundary is sharply defined by the Wasatch Mountains and the Colorado Plateau, while the western boundary is even more distinctly defined by the Sierra Nevada which has been referred to as one of the world's sharpest boundaries between biological regions. By contrast, the Great Basin's northern and southern boundaries are far more subtle topographically and the resultant transition zones are broader and more gradual.
- [4] **Climate** – The climate of the Great Basin is also one of the most variable and extreme in the world. The "rain-shadow" effect imposed by the Sierra Nevada on the Great Basin's western edge results in the capture of the moisture from easterly flowing Pacific storm systems, thereby creating semi-arid to arid continental climates in the basin's interior desert regions. Similarly, the Rocky Mountains on the basin's eastern border intercept potential storm systems coming up from the Gulf of Mexico. Even so, local weather patterns within the Great Basin are complicated by the intervening mountain ranges which tend to uplift the prevailing air flows and disperse the moisture as local storms. Therefore, depending on changes in topography, localized annual precipitation levels can vary from as little as six inches on the valley floors to over 45 inches on the upper elevations of adjacent mountain ranges.
- [5] **Historical Development** – The distribution of the Great Basin's present biological communities was shaped primarily by climatic changes over the most recent glacial event. The Wisconsin Age of the *Pleistocene Epoch*, the last period of glaciation which lasted from about 122,000 to about 10,000 years before present, is the best known of all North American glacial advances and retreats and produced extensive glaciers in the Great Basin's upper mountain regions and enormous *Pluvial Lakes* and marshes in the basin's valley lowlands. During this last Ice Age period the Great Basin could be geographically divided into five distinct regions: (a) Northwest Lakes of southern Oregon; (b) Lahontan System of northern and western Nevada and northeastern California and once containing the Great Basin's second largest Pleistocene lake, *Lake Lahontan*; (c) Central Basins of central Nevada; (d) Bonneville System of eastern Nevada and western Utah and once containing the Great Basin's largest Pleistocene lake, *Lake Bonneville*; and (e) Death Valley System of southern Nevada and southeastern California.

The higher effective moisture (a combination of cooler temperature and/or greater precipitation) characterizing the late Pleistocene Epoch greatly affected the distribution of plant and animal communities throughout the Great Basin. The Holocene Epoch (covering approximately the last 10,000 years) has resulted in less effective moisture than during the Pleistocene and especially the Wisconsin Age. These changing climatic patterns have resulted in the northward and/or elevational migration of many plant species. The Great Basin's physical and floristic characteristics have tended to divide this region into seven vegetation zones characterized as follows:

- [1] **Absolute Desert** – includes playas, salt barrens, and sand dunes;
- [2] **Mojavean Zone** – encompasses most of the geographic area of the Mojave Desert with the exception of the higher mountains, dominated by creosotebush scrub, saltbush scrub, shadscale scrub, blackbrush scrub, Joshua-tree woodland and annual vegetation;
- [3] **Shadscale Zone** – named after its dominant plant species, but is also populated by many other species of widely spaced, drought-tolerant shrubs that are usually thorny with small leaves;
- [4] **Sagebrush-Grass Zone** – the largest of all vegetative zones in the Great Basin and the most contiguous, in addition to the dominant big sagebrush, several other sagebrush species and subspecies also occur and can be locally dominant. This zone has higher precipitation than that of the shadscale zone and supports greater richness of shrubs, grasses, and perennial forbs;
- [5] **Pinyon-Juniper and Western Juniper Zone** – typically defined as the lowest elevation of the broader montane zone, this zone's plant communities are supported by higher precipitation on the mountain slopes resulting in woodlands of pinyon pine and several species of juniper with understories of grasses, perennial forbs and shrubs (principally sagebrush and bitterbrush);
- [6] **Montane Zone** – constitutes the more restricted montane area between the montane's lower pinyon-juniper zone and

the upper alpine zone, with a common feature being the widespread occurrence of quaking aspens and usually few or no conifer species in the basin's northern ranges; curl-leaf mountain-mahogany also provides important habitat in this zone;

- [7] **Alpine Zone** – the uppermost montane zone, strictly defined as beginning at the limit of the upper tree line; relatively restricted to only a few of the highest mountain ranges and constitutes the smallest of the principal zones within the Great Basin.

Great Diurnal Range — (Oceanography) The vertical difference between mean higher high water and mean lower low water.

Great Divide — The watershed of North America comprising the line of highest points of land separating the waters flowing west from those flowing north or east, coinciding with various ranges of the Rocky Mountains, and extending south-southeast from Northwestern Canada to Northwestern South America. More commonly referred to as the *Continental Divide*.

Great Ice Age — See *Ice Age*.

Great Lakes [United States and Canada] — (Background) The Great Lakes represent a unique national and global resource, containing 20 percent of the earth's surface fresh water and supporting within the lakes' drainage area over 38 million people, or approximately 25 percent of the combined populations of the United States and Canadian. The Great Lakes provide resources to support millions of jobs, including tourism, and over \$4 billion per year each for the fishery and boating and recreation industries. The Great Lakes sustain nearly 11 percent of the total employment and 15 percent of the manufacturing employment for the United States and Canada. (Hydrologic Components) The Great Lakes hydrologic system includes the following principal components:

- [1] **Lake Superior** – Not only is this the largest of the five Great Lakes, it also has the largest surface area of any freshwater lake in the world. It contains almost 3,000 cubic miles (12,500 cubic km) of water, a volume that could fill all the other four Great Lakes plus three additional Lake Eries. With an average depth approaching 500 feet (152 meters), Lake Superior also is the coldest and deepest (1,332 feet, or 406 meters, maximum depth) of the Great Lakes. The lake stretches approximately 350 miles (560 km) from west to east, and 160 miles (260 km) north to south, with a shoreline almost 2,800 miles (4,500 km) long. Lake Superior's drainage basin, totaling 49,300 square miles (127,700 square km), includes parts of the states of Michigan, Minnesota and Wisconsin, and the Canadian province of Ontario. Most of Lake Superior's water basin is sparsely populated and heavily forested, with little agriculture due to a cool climate and relatively poor soils. Lake Superior is connected to Lake Huron by the St. Marys River.
- [2] **Lake Michigan** – The second largest Great Lake by volume with 1,180 cubic miles (4,900 cubic km) of water, Lake Michigan is the only Great Lake contained entirely within the United States. Approximately 118 miles (190 km) wide and 307 miles (494 km) long, Lake Michigan has more than 1,600 miles (2,570 km) of shoreline. Averaging 279 feet (85 meters) in depth, the lake reaches a maximum depth of 925 feet (282 meters). The lake's northern tier is in the colder, less developed upper Great Lakes region, while its more temperate southern basin contains the densely-populated Milwaukee and Chicago metropolitan areas. The Lake Michigan drainage basin, approximately twice as large as the 22,300 square miles (57,800 square km) of surface water, includes portions of the states of Illinois, Indiana, Michigan and Wisconsin. Lake Michigan is hydrologically inseparable from Lake Huron, and is joined by the wide Straits of Mackinac.
- [3] **Lake Huron** – Lake Huron is the third largest of the Great Lakes by volume, with 850 cubic miles (3,500 cubic km) of water. Lake Huron's shoreline extends 3,827 miles (6,159 km) and is characterized by shallow, sandy beaches and the rocky shores of Georgian Bay. The lake measures 206 miles (332 km) across and 183 miles (295 km) north to south, with an average depth of 195 feet (60 meters) and approximately 750 feet (230 meters) at its maximum depth. Lake Huron's drainage area, which covers parts of the state of Michigan and the Canadian province of Ontario, is relatively large compared to the other Great Lakes. It's more than twice the size of Lake Huron's surface area of approximately 23,000 square miles (59,600 square km). The Saginaw River basin is intensively farmed and contains the Flint and Saginaw-Bay City metropolitan areas. Lake Huron is connected to Lake St. Clair by the St. Clair River; Lake St. Clair is then connected to Lake Erie through the Detroit River.
- [4] **Lake Erie** – Lake Erie is the smallest of the Great Lakes in volume (116 cubic miles, or 484 cubic km) and is exposed to the greatest effects from urbanization and agriculture. Measuring 241 miles (388 km) across and 57 miles (92 km) from north to south, the lake's surface is just under 10,000 square miles (25,900 square km), with 871 miles (1,400 km) of shoreline. The average depth of Lake Erie is only about 62 feet (19 meters) and 210 feet (64 meters) at its maximum depth. It therefore warms rapidly in the spring and summer, and frequently freezes over in winter. Lake Erie's drainage basin covers parts of the states of Indiana, Michigan, Ohio, Pennsylvania and New York, and the Canadian province of Ontario. Because of its fertile soils, the Lake Erie basin is intensively farmed and is the most densely populated of the five lake basins. Lake Erie is connected to Lake Ontario by the Niagara River and Niagara Falls.
- [5] **Lake Ontario** – Lake Ontario is similar to Lake Erie in length and breadth (193 miles by 53 miles, or 310 km by 85 km). Yet with its greater average depth (approximately 283 feet, or 86 meters), Lake Ontario holds almost four times the volume (393 cubic miles, or 1,640 cubic km) of Lake Erie and has a retention time of about 6 years. The drainage basin covers parts of the Canadian province of Ontario and the state of New York, and a small portion of the state of Pennsylvania. Major urban industrial centers, such as Hamilton and Toronto, are located along its shoreline. The U.S. shore is less urbanized and is not intensively farmed. Lake Ontario flows directly into the St. Lawrence River.
- [6] **Lake St. Clair** – While not strictly considered as one of the "Great Lakes," Lake St. Clair lies along the St. Lawrence

River between Lake Huron and Lake Erie and is the smallest lake in the Great Lakes system. Heart-shaped and shallow (averaging only 10 feet or 3 meters deep), the lake requires periodic dredging to ensure bottom clearance for large ships. The northeastern portion of Lake St. Clair is an extensive delta system, the largest within the Great Lakes basin. The Michigan portion of the delta has been urbanized, while the province of Ontario has set aside much of the wetlands as the Walpole Indian Reservation. Wetland loss from urban and recreational encroachment continues to be a problem on the U.S. side, while in Ontario, many of the wetland areas have been wiped out by agricultural drainage. Together, the Lake Erie-Lake St. Clair drainage basin is a 22,300-square-mile (57,800-square-km) area that drains to the Great Lakes from parts of the states of Michigan, Indiana, Ohio, Pennsylvania and New York.

- [7] **St. Lawrence River** – The St. Lawrence River and Seaway is of vital geographic and economic importance to the Great Lakes system, connecting the lakes to the Atlantic Ocean and providing navigation to deep-draft ocean vessels. Approximately 800 miles (1,290 km) long, the St. Lawrence River can be divided into three broad sections: (a) the freshwater river, which extends from Lake Ontario to just outside the city of Quebec; (b) the St. Lawrence estuary, which extends from Quebec to Anticosti Island; and (c) the Gulf of St. Lawrence, which leads into the Atlantic Ocean. The St. Lawrence River drops 226 feet (69 meters) between Lake Ontario (the last of the Great Lakes) and Montreal, Canada. To allow vessels to pass through the river and in and out of the Great Lakes, the St. Lawrence Seaway, a massive American-Canadian navigational project, was begun in 1954 and completed in 1959. The Seaway created the final link in the Great Lakes-St. Lawrence River system, connecting Duluth, Minnesota, some 2,340 miles (3,770 km) away, with the head of the Gulf of St. Lawrence, through a complex system of lakes, rivers, deepened channels, locks, and canals.

(Glacial History) The basins that contain what we call the Great Lakes are primarily the result of glaciation that occurred during the Pleistocene, or glacial epoch (the earlier of two epochs of the Quaternary period) which lasted from 500,000 years before present (B.P.) to 11,000 B.P. Geologically speaking the Great Lakes are extremely young and are less than 10,000 years old. The modern Great Lakes, like all lakes, will be geologically short-lived and are just transitory features of an ever-changing landscape. Shores are constantly being eroded by wave action, and the lakes will ultimately be destroyed by a combination of sediment filling and downcutting of their outlets by their discharging rivers. The Great Lakes are basically the result of glacial scouring of pre-existing stream valleys. The axis of each valley is oriented along a belt of weaker rock and the divides, the areas between the valleys, were developed on more resistant rock. Basically, the basins are in depressions of “soft” rock (which is erodible) surrounded by more resistant (or less-erodible) “hard” rock. The Great Lakes basin has two basic kinds of bedrock: (1) very hard crystalline rocks that are part of the Canadian Shield which are from 520 million to 2.7 billion years of age (Precambrian rocks); and (2) softer sedimentary rock of the Paleozoic era and are 200 million to 520 million years old. There were at least 4 glaciations in recent times each marked by advances and retreats: (1) Nebraskan which began about 1 million years B.P.; (2) Kansan about 700 thousand years B.P.; (3) Illinoian about 225 thousand years B.P.; and (4) the Wisconsin about 22 thousand years B.P. (See *Geologic Time Chart*) During the glacial maxima the whole of the Great Lakes area was covered in ice. The history of the modern Great Lakes began approximately 15,000 years B.P. with the final retreat of the Wisconsin ice sheet. (Pollution and Water Quality Issues) The Great Lakes are a vast and economically important resource, but they are a resource that is heavily stressed by population, development, and resultant pollution. Part of the region’s unique ecological and environmental nature stems from the nearly closed nature of the Great Lake system. Lakes Superior, Michigan, and Huron have especially long water retention times, making them particularly susceptible to pollutant buildup. On the average, water that enters Lake Superior takes 182 years to be flushed out again, compared with 106 years for Lake Michigan, and just 2.7 years for the much shallower Lake Erie. Concentrations of toxic contaminants that *Bioaccumulate* to a high degree continue to threaten this region’s environmental conditions. Environmental problems are persistent and diverse, ranging from *Eutrophication* (excessive biological productivity due to nutrient enrichment) to the accumulation of toxic substances. In the most recent assessment of water quality, the *U.S. Environmental Protection Agency (EPA)* found that 97 percent of the Great Lakes’ shoreline waters do not fully support designated uses overall due to problems of persistent toxic pollutants. Even so, according to analyses by Canadian and U.S. officials, all of the lakes show substantial improvement compared to their conditions 30 years ago. The principal effort to address the complex pollution problems of these lakes is the Great Lakes Water Quality Initiative, now being implemented by the Great Lakes states pursuant to guidance issued by the EPA in 1995. Also see *Great Lakes Program*.

Great Lakes Program [United States and Canada] — The Great Lakes Program represents one of the most comprehensive and extensive environmental remediation and restoration efforts in the world. The Great Lakes – to include Lakes Superior, Michigan, Huron, Erie, and Ontario – represent a North American natural resource treasure of inestimable value. There has been over 90 years of international and interstate cooperation on Great Lakes issues. Four of the five Great Lakes – Superior, Huron, Erie, and Ontario – are shared with Canada. The Boundary Waters Treaty of 1909 and the 1987 Great Lakes Water Quality Agreement (GLWQA) with Canada provide the basis for international efforts to manage this shared resource. Additional responsibilities are defined in Section 118 of the *Clean Water Act (CWA)*, Section 112 of the Clean Air Act Amendments, and the Great Lakes Critical Programs Act of 1990. The Great Lakes 5-Year Strategy, developed jointly by the *U.S. Environmental Protection Agency (EPA)* and its multi-state, multi-agency partners and built on the foundation of the GLWQA, provides the agenda for Great Lakes ecosystem management: (a) reducing toxic substances; (b) protecting and restoring important habitats; and (c) protecting human/ecosystem species health. Since the signing of the initial GLWQA in 1972, programs and policies to restore and protect the Great Lakes Ecosystem have served as a world-wide model for cooperative environmental protection and natural resource management. There have been many successes, and the ecosystem is in recovery. For example, excess nutrient loads which choked the Great Lakes with nuisance algae have been successfully addressed. New ways of doing business such as pioneering multi-media programs to prevent toxic pollution have been initiated and have become national models. Basin-wide efforts have been initiated to protect critical habitats which support the unique plants, fish and other aquatic life, and wildlife found in this

freshwater ecosystem. While many efforts are underway, much work remains to be done. To accomplish its objectives, the EPA has established a Great Lakes National Program Office (GLNPO), located in Chicago, Illinois. On behalf of the U.S. commitment, the GLNPO brings together federal, state, tribal, local, and industry partners in an integrated, ecosystem approach to protect, maintain, and restore the chemical, biological, and physical integrity of the Great Lakes. The program (a) monitors the Great Lake ecosystem indicators; (b) manages and provides public access to Great Lakes data; (c) helps communities address contaminated sediments in their harbors; (d) supports local protection and restoration of important habitats; (e) promotes pollution prevention through activities and projects such as the Canada-U.S. Binational Toxics Strategy (BNS); and (f) provides assistance for community-based Remedial Action Plans for Areas of Concern and for Lakewide Management Plans. Each year, GLNPO uses its funding to assist Great Lakes partners in these areas through grants, interagency agreements, and contracts. U.S. government agency partners to the Great Lakes Program include the *U.S. Army Corps of Engineers (Corps)*, U.S. Environmental Protection Agency (EPA) [GLNPO], U.S. Coast Guard, U.S. Department of Agriculture (USDA) [to include the *Natural Resources Conservation Service (NRCS)*], the Cooperative State Research, Education, and Extension Service (CREES), and the Farm Services Agency (FSA), *National Oceanographic and Atmospheric Administration (NOAA)*, *U.S. Fish and Wildlife Service (USFWS)*, *U. S. Geological Survey (USGS)*, Agency for Toxic Substances and Disease Registry, U.S. Forest Service (USFS) and National Park Service (NPS), and the Great Lakes Fishery Commission. State partners include the States of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and the Great Lakes Tribal Governments. The critical nature of the Great Lakes Program lies in the critical importance of the Great Lakes Basin. The Great Lakes are the largest system of surface freshwater on the earth, containing roughly 20 percent of the world's supply (5,500 cubic miles or about 6 quadrillion gallons of water). The water in the Great Lakes accounts for 95 percent of all the surface freshwater in the United States. In the U.S., the Great Lakes are considered a fourth seacoast. The total shoreline (U.S. and Canadian, including connecting channels and islands) is over 10,000 miles, or about 40 percent of the earth's circumference. The Great Lakes basin holds major urban/suburban areas that are home to more than one-tenth of the U.S. population of the United States, and one-quarter of the population of Canada (a total of over 33 million people). Over 30 million people in the U.S. and in Canada rely on the Great Lakes as a source of drinking water. The basin contains many thriving, ecologically rich areas. The Great Lakes ecosystem includes such diverse elements as northern evergreen forests, deciduous forests, tall grass and lake plain prairies, sandy barrens, alvars, dunes, and coastal wetlands. Over thirty of the basin's biological communities -- and over 100 species -- are globally rare or found only in the Great Lakes basin. The wealth of natural resources has long made the region a heartland of both the Canadian and U.S. industrial economies. The long-term vision for the Great Lakes ecosystem can be expressed simply as follows:

- All Great Lakes beaches are open for swimming all the time;
- All Great Lakes fish are safe to eat all the time;
- The Great Lakes are maintained and enhanced as a safe source of drinking water; and
- The Great Lakes Basin is a healthy natural environment for wildlife and people.

Parties to the Great Lakes Program have established four major areas of remediation and protection:

- [1] **Chemical Integrity** – Reduce toxic substances in the Great Lakes Basin Ecosystem, with an emphasis on persistent bioaccumulative substances, so that all organisms are protected. Over time, these substances will be virtually eliminated. Maintain an appropriate nutrient balance to ensure ecosystem health.
- [2] **Physical Integrity** – Protect and restore the physical integrity of the Great Lakes, including habitats vital for the support of healthy and diverse communities of plants, fish, and other aquatic life and wildlife in the Great Lakes Basin Ecosystem. Protect Great Lakes water as a regional natural resource from diversions and exports.
- [3] **Biological Integrity** – Protect human and biological health. Restore and maintain stable, diverse and self-sustaining populations of fish and other aquatic life, wildlife, and plants in the Great Lakes Basin Ecosystem, including controlling and eliminating pathogens and preventing the introduction and spread of invasive species to the maximum extent possible, to protect human health, biological health and economic vitality.
- [4] **Working Together** – Work together as an environmental community to establish effective programs, coordinate authorities and resources, report on progress, and hold forums for information exchange and collective decision-making, so the Great Lakes are protected and the objectives of the Agreement are achieved.

Desired outcomes for the Great Lakes Program include:

- [1] **Fishability** – There shall be no restrictions on the human consumption of fish in the waters of the Great Lakes Basin ecosystem as a result of anthropogenic (human) inputs of persistent toxics;
- [2] **Swimmability** – No public bathing beaches will be closed as a result of human activities, or conversely, all beaches are open and available for public swimming;
- [3] **Drinkability** – Treated drinking water is safe for human consumption; human activities do not result in application of consumption restrictions;
- [4] **Healthy Human Populations** – Human populations in the Great Lakes are healthy and free from acute illness associated with locally high levels of contaminants, or chronic illness associated with long-term exposure to low levels of contaminants;
- [5] **Economic Viability** – A regional economy that is viable, sustainable, and provides adequate sustenance and dignity for the human population of the Great Lakes;
- [6] **Biological Community and Integrity** – Maintenance of the diversity of biological communities, species, and genetic variations within a species;
- [7] **Elimination of Toxic Substances** – Virtual elimination of inputs to the Great Lakes system of persistent toxic substances;

- [8] **Absence of Excess Phosphorus** – Absence of excess phosphorus entering the water as a result of human activity;
 [9] **Physical Environmental Integrity** – Land development and use compatible with maintaining aquatic habitat of a quantity and quality necessary and sufficient to sustain an endemic assemblage of fish and wildlife populations; and
 [10] **Water Quantity** – There will be no diversion of Great Lakes waters that adversely affects any aspect of the basin.

Also see *Chesapeake Bay Program*.

Great Salt Lake [Utah] — The first white person known to have visited the lake was Jim Bridger in 1825. Other fur trappers, such as Etienne Provost, may have beaten Bridger to its shores, but there is no proof of this. The first scientific examination of the lake was undertaken in 1843 by John C. Fremont; this expedition included the legendary Kit Carson. A cross, carved into a rock near the summit of Fremont Island, reportedly by Carson, can still be seen today. The Great Salt Lake is the present-day remnant of the ancient Ice Age *Lake Bonneville*, which existed in this same basin from about 32,000 to 14,000 years before present (B.P.). Lake Bonneville occupied the lowest, closed depression in the eastern *Great Basin* and at its largest extent covered nearly 20,000 square miles of western Utah and smaller portions of eastern Nevada and southern Idaho. Much of the salt now contained in the Great Salt Lake was originally in the water of Lake Bonneville. Even though Lake Bonneville was fairly fresh, it contained salt that concentrated as its water evaporated. About two million tons of dissolved salts enter the lake each year by this means. The Great Salt Lake receives its waters from four main rivers and numerous small streams (66 percent), direct precipitation into on the lake's surface (31 percent), and from groundwater inflows (3 percent). The total average annual inflow to the lake is about 2.9 million acre feet of water. The main rivers entering the lake are the Bear River from the north, the Weber and Ogden Rivers from the east, and the Jordan River from the south. The drainage basin of the lake covers an area of about 21,500 square miles. The Great Salt Lake averages approximately 75 miles long by 35 miles wide at a surface elevation of about 4,200 feet above mean sea level (MSL). At this elevation, the lake covers an area of 1,034,000 acres (1,620 square miles), and has a maximum depth of about 33 feet. It is reported to be the 33rd largest lake in the world, and the largest fresh or saltwater lake in the United States after the Great Lakes. On average, the lake level fluctuates one to two feet annually, rising to its highest level during May through July (following the melting of the mountain snowpack) and dropping to its lowest point during October through November (after the hot summer months). In historical time (1847 to the present), fluctuations of the lake level have varied over a range of 20 feet from a low of 4,191.35 feet in 1963 to a high of 4,211.85 feet in 1986-1987. The historical average elevation of the lake is about 4,200 feet. Because of the very shallow nature of the lake, even modest changes in its elevation result in relatively large changes in the lake's area, volume, and salinity. The lake contains 11 recognized islands, although this number varies depending on the level of the lake. Seven islands are in the southern portion of the lake and four in the northwestern portion. The large islands in the southern portion are named Antelope, Stansbury, Fremont, and Carrington. The smaller islands are named Badger, Hat (Bird), and Egg. The four small islands in the northwestern portion are Dolphin, Gunnison, Cub, and Strongs Knob. Great Salt Lake is divided into two parts by the Southern Pacific Transportation Co. (SPTC) causeway. Since the construction of the solid-fill causeway, the salt content (salinity) of the north arm has become greater than the south arm. This is due to the following: (1) the south arm receives nearly all of the freshwater tributary inflow to the lake, and (2) the north arm is fed mainly by south arm salty water seeping through the causeway and flowing through the culverts and the breach opening. Currently, the north arm of the lake is near its salt-saturation point (24-26 percent, or approximately 175,000 parts per million TDS) and is about twice as salty as the south arm (12-14 percent, or approximately 85,000 ppm). In historical time, the lake's salinity has ranged from a little less than 5 percent, (just above that of sea water), to nearly 27 percent (beyond which water cannot hold more salt).

Source Body	Sodium	Potassium	Magnesium	Calcium	Chloride	Sulfate
Great Salt Lake	32.8%	2.0%	3.3%	0.2%	54.5%	7.2%
Ocean (typical)	30.8	1.1	3.7	1.2	55.5	7.7
Dead Sea	12.3	2.3	12.8	5.3	67.2	0.1

The chemical composition of Great Salt Lake is similar to that of typical ocean water. Sodium and chloride are the major ions in the water, followed by sulfate, magnesium, calcium, and potassium. For comparison, the table above shows the concentration of the six major ions in water of Great Salt Lake, a typical ocean, and the Dead Sea. Chemical compositions (presented as dry weight percentages) of Great Salt Lake, typical ocean, and the Dead Sea waters.

Greater Ebb — (Oceanography) The stronger of two ebb currents of a tidal day.

Greater Flood — (Oceanography) The stronger of two flood currents of a tidal day.

Green Line — A specific area where a more or less continuous cover of perennial vegetation is encountered when moving away from the perennial water source.

Green Mud — (Oceanography) A greenish, fine-grained, oceanic mud containing chlorite and glauconite minerals that are responsible for its coloration.

Green Snow — A snow surface having a greenish tint, caused by the growth of microscopic green algae.

Greenbelt — (1) A strip of natural vegetation growing parallel to a stream that provides wildlife habitat and an erosion and flood buffer zone. This strip of vegetation also retards rainfall runoff down the bank slope and provides a root system that binds soil particles together. (2) An area where measures are applied to mitigate fire, flood and erosion hazards to include fuel management (suppression of combustibles), land use planning, and development standards. More traditionally, an irrigated landscaped buffer zone between developed areas and wildlands, usually put to additional uses such as parks, bike and riding trails, golf courses, etc.

Greenhouse Effect — (1) The trapping of the sun's heat on earth by water vapor and carbon monoxide, thus accounting for the

temperature of the earth. (2) The phenomenon whereby the earth's atmosphere traps solar radiation, caused by the presence in the atmosphere of gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through but absorb heat radiated back from the earth's surface. As the amount of carbon dioxide increases due to the combustion of fossil fuels and deforestation, especially of tropical rain forests, it is proposed that more heat energy will be retained by the earth's atmosphere, resulting in a change in rainfall and wind patterns and melting of the polar ice, thus raising the global sea level. The change in weather patterns could have devastating consequences to the world's present prime agricultural areas. A significant rise in sea level could flood many coastal cities and damage ecologically important coastal wetlands. Other heat-absorbing gases that are increasing in the atmosphere as a result of human activities are nitrous oxide and chlorofluorocarbons.

Greenhouse Gas — (Ecology) A term for a gas such as carbon dioxide or methane that increases global temperatures by trapping solar electromagnetic radiation.

“Greening” — A flood mitigation concept whereby the banks of rivers, channels, and flood routes are planted with riparian vegetation. Proponents of greening the river banks believe that concrete channels used to direct flood flows to main river systems only serve to increase downstream flooding. Greening and the use of streambank vegetation tends to allow runoff to flow more slowly along natural, ragged banks, and when used in combination with basin retention systems, allows flood flows to percolate and restore groundwater supplies.

Greensand — A mineral (glauconite) material that looks like ordinary filter sand except that it is green in color. Greensand is a natural ion exchange material which is capable of softening water. Greensand which has been treated with potassium permanganate (KMnO_4) is called manganese greensand; this product is used to remove iron, manganese and hydrogen sulfide from groundwaters.

Greywater (Graywater or Gray Water) — Wastewater from clothes washing machines, showers, bathtubs, hand washing, lavatories and sinks that are not used for disposal of chemicals or chemical-biological ingredients. Less commonly spelled *Graywater* or *Gray Water*.

Grey (Gray) Water Reuse — Reuse, generally without treatment, of domestic type wastewater for toilet flushing, garden irrigation and other nonpotable uses. Excludes water from toilets, kitchen sinks, dishwashers, or water used for washing diapers.

Grinder Pump — (Wastewater Treatment) A small submersible centrifugal pump with an impeller designed to serve as a pump with grinder elements which grind solids into small pieces that pass through the pump impellers.

Grit — Dense inorganic matter, such as sand and gravel, present in water or sewage.

Grit Chamber — A small detention basin designed to permit the settling of inorganic materials while passing the organic fraction.

Grit Removal — The process of removing sand and fine gravel from a stream of domestic waste in a *Grit Chamber*.

Groin — A small jetty extending from a shore to protect a beach against erosion or to trap shifting sands.

Gross Alpha Particle Activity — The total radioactivity due to alpha particle emission as inferred from measurements on a dry sample.

Gross Beta Particle Activity — The total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

Gross Duty of Water — (Irrigation) The irrigation water diverted at the intake of a canal system, usually expressed in depth on the irrigable area under the system. Also see *Net Duty of Water*.

Gross Erosion — The total of all sheet, gully, and channel erosion in a drainage basin, usually expressed in units of mass.

Gross Precipitation — The amount of precipitation measured in the open; that is, before the interception process depletes the amount reaching the ground.

Gross Reservoir Capacity — The total storage capacity available in a reservoir for all purposes, from the streambed to the normal maximum operating level. Includes dead (or inactive) storage, but excludes surcharge (water temporarily stored above the elevation of the top of the spillway).

Gross Water Requirement (Farm) — The *Farm Delivery Requirement* plus the seepage losses in the canal system from the headworks to the farm unit plus the waste of water due to poor operation.

Gross Water Yield — (1) The available water runoff, both surface and subsurface, prior to use by man's activities, use by phreatophytes, or evaporation from free water surfaces. (2) The estimated or actual available water, both surface and sub-surface, prior to agricultural and phreatophytic use. Generally, this water yield is estimated for a stream or streams at a point above the highest diversion for the main body of irrigated land on a flood plain of a valley.

Ground — (1) The solid surface of the earth. (2) The floor of a body of water, especially the sea.

Ground Cover — Plants grown to keep soil from eroding.

Ground Fog — A fog which does not extend to the base of any clouds which may lie above it and covers half or less of the sky.

Ground Ice — (1) Ice found beneath the ground surface, especially a subsurface mass of clear, non-glacial ice within permafrost or seasonally frozen ground. (2) Ice formed on the ground by the compaction or freezing of snow or the freezing of rain. Also see *Anchor Ice*.

Ground Ice Mound — A small frost mound that contains masses of ice.

Ground Penetrating Radar (GPR) — A relatively new method of interpreting stratigraphic sequences and profiles. The GPR process involves shooting electromagnetic energy (radar) into a section of ground being studied using portable dipole transmitting antennae which are placed at ground level over the site. The radar waves are sent into the ground and portions of this energy is reflected back upwards to a receiving antennae and is then processed using appropriate software within a computer to create a side profile of the sedimentary layers. Profiles can then be analyzed to determine stratigraphic content and boundaries, water table elevations, and the presence of archaeological items. GPR has been proven to be an effective means of accomplishing these tasks.

Ground Rupture — The movement of the ground along one side of a *Fault* relative to the other side, caused by an earthquake.

Ground Truth — (Data Analysis and Interpretation) Verification of aerial photointerpretation by observers on the ground.

Ground Water — See *Groundwater*.

Grounded Ice — Ice that has run aground or is in contact with the ground underneath it.

Groundswell (or Ground Swell) — (Oceanography) A long, high ocean swell whose height rises dramatically as it passes through water that is shallower than one-tenth wavelength.

Groundwater (also Ground Water) — (1) Generally, water under the surface, whatever may be the geologic reservoir in which it is standing or moving. All subsurface water is distinct from *Surface Water*; specifically, the part that is in the saturated zone of a defined *Aquifer*. (2) Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper level of the saturated zone is called the *Water Table*. (3) Water stored underground in rock crevices and in the pores of geologic materials that make up the earth's crust. Groundwater lies under the surface in the ground's *Zone of Saturation*, and is also referred to as *Phreatic Water*. (4) Water that occurs beneath the land surface and fills partially or wholly pore spaces of the alluvium, soil or rock formation in which it is situated. Does not include water which is being produced with oil in the production of oil and gas or in a bona fide mining operation.

Groundwater Accounting — See *Groundwater Budget*.

Groundwater Aquifer — See *Aquifer*.

Groundwater Artery — A tube-shaped body of permeable material encased within a matrix of impermeable or less permeable material and saturated with water under artesian pressure.

Groundwater Balance — See *Groundwater Budget*.

Groundwater Barrier — Rock, clay, or other natural or artificial materials with a relatively low permeability that occurs (or is placed) below ground surface, where it impedes the movement of groundwater and thus causes a pronounced difference in the heads on opposite sides of the barrier.

Groundwater Basin — (1) A subsurface basin in which *Groundwater* collects or is retained, or from which groundwater may flow. (2) An *Aquifer* having more or less well-defined boundaries, as well as areas of recharge and discharge. (3) A groundwater reservoir together with all the overlying land surface and the underlying aquifers that contribute water to the reservoir. In some cases, the boundaries of successively deeper aquifers may differ in a way that creates difficulty in defining the limits of the basin. A groundwater basin could be separated from adjacent basins by geologic boundaries or by hydrologic boundaries. (4) A groundwater reservoir defined by all the overlying land surface and the underlying aquifers that contain water stored in the reservoir. Boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.

Groundwater Budget — A quantitative description of the recharge, discharge, and changes in storage of an *Aquifer* or system of aquifers. Also referred to as *Groundwater Accounting* or *Groundwater Balance*.

Groundwater Chemistry in the Unsaturated Zone (Geoindicator/GCRIO) — Changes in recharge rates have a direct relationship to water resource availability. The *Unsaturated Zone* may store and transmit pollutants, the release of which may have a sudden adverse impact on groundwater quality. Water moves downwards through porous soils and sediments and, under favorable conditions, may preserve a record of weathering processes, climatic variations (in the Cl or isotopic signature), or human activities such as agriculture (NO_3) and acidification (H^+). This indicator may be considered as the output from the soil zone and may reflect the properties or change in properties of soils. Rates of downward movement are typically 0.1 to 1.0 meter per year, and a record of individual events (resolution 1-20+ years) may be preserved over a scale of decades or centuries [see *Groundwater Quality* and *Soil Quality*]. In contrast, records collected over periods of years are needed to establish trends from the monitoring of rivers and streams or groundwater discharge. The unsaturated zone is also an important buffering zone for attenuation of acidity, metal content, and some other harmful substances. See *Geoindicators (U.S. Global Change Research Information Office)*.

Groundwater Cleanup Levels [EPA] — Facility-specific chemical concentrations in groundwater that regulators generally establish when defining groundwater cleanup levels for final remedies.

Groundwater Cleanup Objectives [EPA] — Includes three components: groundwater cleanup levels, point of compliance, and cleanup timeframes.

Groundwater, Confined — Groundwater under pressure significantly greater than atmospheric, with its upper limit the bottom of a bed with hydraulic conductivity distinctly lower than that of the material in which the confined water occurs.

Groundwater Decrement — See *Groundwater Discharge*.

Groundwater Depletion Curve — A graph of stream flow over a period of time, indicating the decrease in groundwater runoff after surface runoff to the stream channel has ceased.

Groundwater Discharge — (1) The flow of water from the *Zone of Saturation*. The freeing of water from the *Zone of Saturation*. (2) The water or quantity of water thus freed. Also referred to as *Groundwater Decrement*. (3) (Water Quality) Groundwater entering near coastal waters which has been contaminated by landfill leachate, deep well injection of hazardous wastes, septic tanks, etc.

Groundwater Disposal — Refers to wastewater that is disposed of through the ground either by injection or seepage. This includes the following discharge methods: absorption beds, injection wells, drain fields, percolation ponds, rapid infiltration basins, and spray fields (land application). Land application systems (reuse systems) are considered a groundwater disposal method as the wastewater used to irrigate turf or crops is generally intended to filter down through the soil.

Groundwater Divide — (1) A ridge in the *Water Table* or *Potentiometric Surface* from which groundwater moves away at right angles in both directions. (2) A line on a water table on either side of which the water table slopes downward. It is analogous to a drainage divide between two *Drainage Basins* on a land surface. It is also the line of highest *Hydraulic Head* in the water table or potentiometric surface.

Groundwater Equation — A mathematical statement of the groundwater losses and gains in a given area. a mathematical statement of the groundwater losses and gains in a given area. Specifically, the equation that will balance the groundwater budget, $R = E + S + I$, in which R represents total rainfall, E is loss through evaporation, S is stream flow out of the system, and I is the amount of replenishment.

Groundwater Flow — (1) Water that moves through the subsurface soil and rocks. (2) The movement of water through openings

in sediment and rock that occurs in the *Zone of Saturation*. (3) The movement of water in the zone of saturation by natural or artificial means. Also referred to as *Groundwater Movement*. (4) Water that has been absorbed by the ground and has become groundwater. Also referred to as *Groundwater Runoff*. (5) Streamflow which results from precipitation that infiltrates into the soil and eventually moves through the soil to the stream channel. This is also referred to as *Baseflow*, or *Dry-Weather Flow*.

Groundwater Flow Model — (1) A digital computer model that calculates a hydraulic head field for the modeling domain using numerical methods to arrive at an approximate solution to the differential equation of ground-water flow. (2) Any representation, typically using plastic or glass cross-sectional viewing boxes, with representative soil samples, depicting ground-water flows and frequently used for educational purposes.

Groundwater, Free — Unconfined groundwater whose upper boundary is a free water table.

Groundwater Hydraulics — The study of the movement of water, especially water under pressure and water's movement through various soil medium.

Groundwater Hydrology — The branch of *Hydrology* that deals with *Groundwater*; its occurrence and movements, its replenishment and depletion, the properties of rocks that control groundwater movement and storage, and the methods of investigation and utilization of groundwater. Also referred to as *Groundwater Hydraulics*, although this term pertains more to the study of the motion of water.

Groundwater Lake — A lake whose water represents the exposure of the upper surface of the *Zone of Saturation*.

Groundwater Law — The common law doctrine of *Riparian Rights* and the doctrine of prior appropriation (*Appropriative Rights*) as applied to groundwater. See *Appropriation Doctrine* and *Riparian Doctrine*.

Groundwater Level — (1) The height of the *Water Table* at or in a particular location or area, as determined by the level of water in wells or other depressions that intersect the *Zone of Saturation*. (2) The elevation of the water table or another potentiometric surface at a particular location.

Groundwater Level (Geoindicator) [GCRIO] — Groundwater is the major source of water in many regions, supplying a large proportion of water globally. In the United States, more than half the drinking water comes from the subsurface; in arid regions it is generally the only source of water. The availability of clean water is of fundamental importance to the sustainability of life. It is essential to know how long the resource will last and to determine the present rates of recharge, understanding that *Groundwater Mining* is a terminal condition. Groundwater is replenished from precipitation and from surface water, but the rate of abstraction (withdrawal by humans) may exceed the rate of natural recharge (*Perennial Yield*), leading to reduction of the resource. Some aquifers, especially in arid and semi-arid regions, contain paleowaters (fossil groundwater) stored from earlier periods of wetter climate. The reduction of these reserves which have been built up over the centuries is comparable to "mining". In *Alluvial Plains*, reduction in streamflow reduces the rate of natural recharge to aquifers. Measurement on a regular basis of water levels in wells and boreholes, or of spring discharge provides the simplest indicator of changes in groundwater resources. However, springs may be perennial, intermittent, or periodic, and their discharge may depend on changes in climate, tides, and local underground conditions such as changes in rock stresses. See *Geoindicators [U.S. Global Change Research Information Office]*.

Groundwater Mining — (1) The withdrawal of groundwater through wells, resulting in a lowering of the groundwater table at a rate faster than the rate at which the groundwater table can be recharged. (2) The withdrawal of water from an aquifer in excess of recharge which, if continued over time, would eventually cause the underground supply to be exhausted or the water table could drop below economically feasible pumping lifts. (3) Pumping ground water from a basin where the safe yield is very small, thereby extracting ground water which had accumulated over a long period of time.

Groundwater Mound — Raised area in a water table or other *Potentiometric Surface*, created by *Groundwater Recharge*. See *Groundwater Mounding*.

Groundwater Mounding — Commonly, an outward and upward expansion of the free water table caused by shallow re-injection, percolation below and impoundment, or other surface recharge method (essentially, the reverse of the cone of depression effect created by a pumping well). Mounding can alter groundwater flow rates and direction; however, the effects are usually localized and may be temporary, depending upon the frequency and duration of the surface recharge events.

Groundwater Movement — See *Groundwater Flow*.

Groundwater Outflow — That part of the discharge from a *Drainage Basin* that occurs through the groundwater. The term "underflow" is often used to describe the groundwater outflow that takes place in valley alluvium (instead of the surface channel) and thus is not measured at a *Gaging Station*.

Groundwater Overdraft — (1) Pumpage of *Groundwater* in excess of *Safe Yield*. (2) The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average. Sometimes used interchangeably with *Groundwater Mining*.

Groundwater, Perched — Groundwater that is separated from the main body of groundwater by an impermeable (unsaturated) layer.

Groundwater Plume — A volume of contaminated groundwater that extends downward and outward from a specific source; the shape and movement of the mass of the contaminated water is affected by the local geology, materials present in the plume, and the flow characteristics of the area groundwater.

Groundwater Prime Supply — The long-term average annual percolation to the major groundwater basins from precipitation falling on the land and from flows in rivers and streams. Also includes recharge from local sources that have been enhanced by construction of spreading ground or other means. Recharge of imported and reclaimed water is not included nor is recharge using applied irrigation water.

Groundwater Quality (Geoindicator) [GCRIO] — Groundwater is globally important for human consumption, and changes in groundwater quality can have serious consequences on human existence. It is also important for the support of habitat and for maintaining the quality of baseflow to rivers. The chemical composition of groundwater is a measure of its suitability as a source

of water for human and animal consumption, irrigation, and for industrial uses and other purposes. It also influences ecosystem health and function, so that it is important to detect change and early warnings of change both in natural systems and resulting from pollution. The chemistry (quality) of groundwater reflects inputs from the atmosphere, from soil and water-rock reactions (weathering), as well as from pollutant sources such as mining, land clearance, agriculture, acid precipitation, and domestic and industrial wastes. The relatively slow movement of water through the ground means that residence times in groundwaters are generally orders of magnitude longer than in surface waters. As in the case of *Surface Water Quality*, it is difficult to simplify to a few parameters. However, in the context of *Geoindicators*, a selection has been made of a few important first-order and second order parameters that can be used in most circumstances to assess significant processes or trends at a time-scale of 50-100 years. The following first order indicators (in italics) of change are proposed, in association with a number of processes and problems, and supported by a number of second order parameters:

- [1] ***Salinity*** – Fresh groundwater may be limited laterally by its interface with sea water and adjacent rock types, or vertically by underlying formation waters. Saline water intrusion into coastal aquifers can result from overpumping of fresh groundwater, or when streamflow decreases (e.g. due to dams or diversions) lead to reduced recharge of aquifers in deltas and alluvial plains. Strong evaporation in areas with shallow water tables may also lead to salinization. Changes in levels of salinity may occur due to natural climate change or due to excessive pumping and irrigation practices that stimulate precipitation of dissolved solids as salts on agricultural lands. It is important to monitor overall changes in salinity using Cl or SEC (specific electrical conductance) and, if possible, to characterize the source of the salinity, using one or more secondary indicators. (Geoindicators: Chlorine – Cl, SEC, SO₄, Bromine – Br, TDS (*Total Dissolved Solids*), Magnesium/Calcium – Mg/Ca, Oxygen – $\delta^{18}\text{O}$, Hydrogen – $\delta^2\text{H}$, Fluorine – F);
- [2] ***Acidity and Redox Status*** – Emissions of SO_x and NO_x from industrial sources have, in places, led to an order of magnitude decrease in mean rainfall pH. This has accelerated natural weathering rates and reduced the buffering capacity of soils and rocks, causing an increase in acidity of shallow groundwaters especially in areas deficient in carbonate minerals. Acidification is a major problem to human and ecosystem health in large areas of North America, Northern Europe, Southeast Asia, and South America. The impact on surface waters is exacerbated where the buffering effect of HCO₃ in groundwater baseflow to rivers and lakes is diminished. Changes in the redox status of groundwater (mainly consequent on the reduction of O₂) can also take place rapidly due to microbial or chemical processes in natural systems or as a result of pollution. An increase in acidity (decrease in pH) or a decrease in Eh (redox potential) may give rise to undesirable increases in dissolved metals. The onset of reducing conditions may, however, have benefits such as in situ de-nitrification. (Geoindicators: pH, HCO₃, Eh, DO, Iron – Fe, Arsenic – As);
- [3] ***Radioactivity*** – Natural background radioactivity can be closely related to the presence or absence of rocks and sediments containing uranium or other naturally radioactive materials. Concentrations of dissolved Rn gas provide one means of detecting the presence of natural radioactivity in groundwater [see *Karst Activity*]. Of more significance from an environmental point of view is the possible migration of radionuclides to groundwater from thermonuclear testing, nuclear power plants, and military installations. (Geoindicators: Hydrogen – ³H, Chlorine – ³⁶Cl, Radon – ²²²Rn);
- [4] ***Agricultural Pollution*** – Nitrate levels in groundwater have been increasing over recent decades in most countries as a result of drainage of excess fertilizers. Nitrate, and other mobile fertilizer-derived parameters such as K (K/Na), DOC and SO₄ serve as important tracers of human-induced environmental degradation, though natural denitrification can also occur under reducing conditions (see *Acidity*). Herbicides and pesticides (insecticides, fungicides) and other agrochemicals may also be mobile in groundwaters and can serve as an index of diffuse pollution beneath agricultural lands over the past 20-30 years. Because analysis is extremely difficult, it is not feasible to use these as indicators. Their presence can, however, be inferred if high concentrations of other indicators are present. (Geoindicators: NO₃, SO₄, DOC (dissolved organic carbon), Potassium/Sodium – K/Na, Phosphorus – P, pesticides and herbicides);
- [5] ***Mining Pollution*** – Sulphate derived from the oxidation of sulphide minerals is the best single indicator of pollution from metal and coal mining, oil and gas production, and to a lesser extent from mining exploration activities. A decrease in pH is generally associated with this process, as are increases in the dissolved loads of Fe and other metals that may contaminate both groundwater and surface waters as acid mine drainage. The problem becomes acute for water supplies and ecosystems as groundwater levels rise following mine closures. F and Sr derived from weathering of associated vein minerals may also serve as secondary indicators. (Geoindicators: SO₄, pH, Iron – Fe, Arsenic – As, other metals, Fluorine – F, Strontium – Sr);
- [6] ***Urban and Industrial Pollution*** – The impact of human habitation and disposal of wastes characterized by numerous chemicals is invariably evident in the quality of local groundwater. Many chemicals enter the ground, but the deterioration of water quality may be assessed by those constituents that are most mobile. One key issue is to protect deeper, uncontaminated aquifers and to monitor the effects of contaminant plumes moving into surrounding areas. Thus, DOC, Cl and HCO₃ represent primary indicators of pollution from towns, cities, landfills, and waste dumps. Biological impacts may be measured using indicator organisms such as *E. coli*. However, harmful microorganisms generally fade out within several hundred meters of flow in groundwater, and an alternative is to measure the breakdown products of these biological processes, such as DOC and HCO₃. Secondary indicators include B (where detergents are used), solvents, and hydrocarbons. (Geoindicators: Cl, HCO₃, DOC, Boron – B, hydrocarbons, organic solvents).

Groundwater Recharge — (1) The infiltration of water into the earth. It may increase the total amount of water stored underground

or only replenish the groundwater supply depleted through pumping or natural discharge. (2) The action of increasing groundwater storage by natural conditions or by human activity. The natural or intentional infiltration of surface water into the *Zone of Saturation*, i.e., into the *Groundwater*. (3) Inflow of water to a groundwater reservoir (zone of saturation) from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. Also, the volume of water added by this process. Also see *Artificial Recharge*.

Groundwater Recovery — A rise in the static water level of a well that occurs when the flow from that well or a nearby well ceases.

Groundwater Registration — A statement made by a well owner registering the *Beneficial Use* of groundwater. See (*Prior Appropriation Doctrine*).

Groundwater Replenishment System — A mechanism, process, or procedure intended to provide surface or reclaimed water supplies for groundwater replenishment, i.e., *Groundwater Recharge*. This process could include the use of surplus surface water supplies during periods or seasons of minimal use (e.g., winter time), or the use of relatively high-quality treated effluent which is recharged and/or infiltrated into the *Groundwater Aquifer*.

Groundwater Reservoir — An aquifer or aquifer system in which groundwater is stored. The water may be introduced into the aquifer by artificial or natural means.

Groundwater Reservoir Storage — The amount of water in storage within the defined limit of the aquifer.

Groundwater Resources Association of California (GRA) — The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater through education and technical leadership. The GRA recognizes that groundwater is the largest, accessible source of freshwater on the planet. Groundwater is also the largest source of freshwater available in California and is used to meet almost half of the state's water needs. California's economy, the seventh largest in the world, relies heavily on groundwater to meet the needs of cities, agriculture, industry and other businesses. Groundwater also serves as a freshwater savings account that people rely on during droughts when surface water supplies are reduced. The primary objectives and purpose of the GRA are:

- [1] Promote professional development of scientists, engineers, and others involved in the assessment, development, quality, and management of the state's groundwater resources;
- [2] Help formulate statewide policy on the development, management, and protection of the state's groundwater resources, soil and groundwater remediation, and environmental assessments;
- [3] Disseminate scientific and technical information among GRA members and those who influence policy development concerning groundwater resources;
- [4] Develop scientific educational programs that promote the understanding and implementation of groundwater assessment, protection, and management;
- [5] Facilitate the development of alternative technologies and standardization of methods to advance investigation, management, and protection of California's groundwater resources;
- [6] Develop a pro-active role with the legislature as an authority on technical groundwater issues.; and
- [7] The GRA assumes a leadership role in communicating the needs and values of our industry to government officials and the public. Through the GRA, established committees and individual members can help influence the future groundwater policy of the State of California.

Groundwater Runoff — A portion of runoff which has passed into the ground, has become groundwater, and has been discharged into a stream channel as spring or seepage water. See *Groundwater Flow*.

Groundwater Storage — The storage of water in groundwater reservoirs.

Groundwater Storage Capacity — The space or voids contained in a given volume of soil and rock deposits. Also, the reservoir space contained in a given volume of deposits. Under optimum conditions of use, the usable groundwater storage capacity volume of water that can be alternately extracted and replaced in the deposit, within specified economic limitations.

Groundwater System — All the components of subsurface materials that relate to water, including *Aquifers* (confined and unconfined), *Zones of Saturation*, and *Water Tables*.

Groundwater Table — (1) The surface between the *Zone of Saturation* and the *Zone of Aeration*; the surface of an *Unconfined Aquifer*. The upper surface of the zone of saturation (all pores of subsoil filled with water), except where the surface is formed by an impermeable body. (2) The depth below the surface of the ground where the soil is saturated (the open spaces between the individual soil particles are filled with water). (3) The upper surface of the zone of saturation for undergroundwater. It is an irregular surface with a slope or shape determined by the quantity of groundwater and the permeability of the earth materials. In general, it is highest beneath hills and lowest beneath valleys. Also referred to as the *Water Table*.

Groundwater, Unconfined — Water in an *Aquifer* that has a *Water Table*.

Groundwater Under the Direct Influence (UDI) of Surface Water — Any water beneath the surface of the ground with: (1) a significant occurrence of insects or other microorganisms, algae, or large-diameter *Pathogens*; or (2) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Under direct influence conditions are determined for individual sources in accordance with criteria established by the state. The state determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation.

Groundwater Use [EPA] — Groundwater use refers to the current use and reasonably expected use of the groundwater. When people think about groundwater use, they often consider only drinking water use; however, there are many other groundwater uses besides drinking water. These uses include, for example, sanitary water, cooling water, car washes, livestock watering, and agricultural irrigation. See *Groundwater Use Classification System [EPA]*.

Groundwater Use Classification System [EPA] — The *U.S. Environmental Protection Agency's (EPA)* groundwater use classification system is designed to identify site-specific groundwater use designations and guidelines. These guidelines describe

three classes of groundwater that represent a hierarchy of groundwater resource values to society: (a) Class I is groundwater that is an irreplaceable source of drinking water and/or ecologically vital; (b) Class II is groundwater currently used or potentially usable as a source of drinking water; and (c) Class III includes groundwater that is not a current or potential source of drinking water. The EPA has determined that a groundwater use designation is a determination of the reasonably expected use(s), resource value (e.g., priority), and/or vulnerability of groundwater in a particular area. A system used to make protective groundwater use designations should account for these factors and be:

- [1] Based on an overall goal that is no less protective than EPA's groundwater protection goal;
- [2] Applied consistently to all groundwaters of a State; and
- [3] Developed with thorough opportunity for public participation.

The EPA has further defined groundwater use, value, and vulnerability as follows:

- Groundwater "Use" – Groundwater use refers to the current use and reasonably expected use of the groundwater. When people think about groundwater use, they often consider only drinking water use; however, there are many other groundwater uses besides drinking water. These uses include, for example, sanitary water, cooling water, car washes, livestock watering, and agricultural irrigation.
- Groundwater "Value" – The value of groundwater depends on the current and reasonably expected use, but it also considers groundwater's potential impact on other media; exposures to contaminants from groundwater can occur even when there is no direct use of the groundwater. For example, groundwater may recharge adjacent or underlying aquifers that are used for drinking water, or discharge to surface water to support aquatic life, recreation, and drinking water. In addition, exposure to contaminated indoor air can result from underlying groundwater contaminated with volatile chemicals. Value also refers to the irreplaceability of groundwater either as a source of drinking water (e.g., sole source aquifer) or to support vital ecological systems.
- Groundwater "Vulnerability" – The vulnerability of groundwater is the relative ease with which a contaminant introduced into the environment can migrate to an aquifer under a given set of management practices, contaminant properties, and aquifer hydrogeologic characteristics.

The EPA has identified a number of factors to assess in determining the use, value, and vulnerability of the nation's groundwater resources. These include:

- [1] Vulnerability to contamination;
- [2] Hydrogeologic regimes (recharge and discharge areas);
- [3] Flow patterns;
- [4] Quantity and potential yield;
- [5] Ambient and/or background quality;
- [6] Wide-spread contamination;
- [7] Current use and exposures (including public water supply systems and private drinking water supply wells);
- [8] Reasonably expected future uses (based on demographics, remoteness, and availability of alternative water supplies);
- [9] Connections to surface waters;
- [10] Impacts to ecological receptors;
- [11] Value attributed to a groundwater resource, including public opinion; and
- [12] Governmental and legal boundary considerations (e.g., groundwater migrating across state boundaries).

Groundwater Use Designation [EPA] — A U.S. Environmental Protection Agency (EPA) program to aid in the determination of reasonably anticipated use, resource value (e.g., priority), and/or vulnerability of groundwater in a particular area. See *Groundwater Use Classification System [EPA]*.

Groundwater Value [EPA] — The value of groundwater depends on the current and reasonably expected use, but it also considers groundwater's potential impact on other media; exposures to contaminants from groundwater can occur even when there is no direct use of the groundwater. For example, groundwater may recharge adjacent or underlying aquifers that are used for drinking water, or discharge to surface water to support aquatic life, recreation, and drinking water. In addition, exposure to contaminated indoor air can result from underlying groundwater contaminated with volatile chemicals. Value also refers to the irreplaceability of groundwater either as a source of drinking water (e.g., sole source aquifer) or to support vital ecological systems. See *Groundwater Use Classification System [EPA]*.

Groundwater Velocity — The rate of water movement through openings in rock or sediment. Also see *Darcy's Law*.

Groundwater Vulnerability [EPA] — The vulnerability of groundwater is the relative ease with which a contaminant introduced into the environment can migrate to an aquifer under a given set of management practices, contaminant properties, and aquifer hydrogeologic characteristics. See *Groundwater Use Classification System [EPA]*.

Groundwater Withdrawal — Any process through which groundwater is removed from a source.

Group Velocity — (1) (Physics) The velocity of a packet of waves having different frequencies and phase velocities. (2) (Oceanography) The overall velocity of a group of component simple harmonic ocean waves; in deep water half the velocity of an individual wave but in shallow water the same as the velocity of an individual wave.

Grout — (1) A slurry which is used to form a permanent, impervious seal in the annular space or to fill and seal abandoned holes or wells. (2) A pumpable slurry of cement or a mixture of cement and fine sand, commonly forced into a borehole to seal crevices in a rock. (3) A fluid mixture of cement and water (neat cement) of a consistency that can be forced through a pipe and placed as required. Various additives, such as sand, bentonite, and hydrated lime, may be included in the mixture to meet certain requirements. Bentonite and water are sometimes used for grout.

Grout Curtain — (Dam) A barrier produced by injecting grout into a vertical zone, usually narrow horizontally, in the foundation

of a dam to reduce seepage under the dam. Also referred to as *Grout Cutoff*.

Grouting — The operation by which grout is placed between the casing and the sides of the well bore to a predetermined height above the bottom of the well. This secures the casing in place and excludes water and other fluids from the well bore.

Growing Season — (1) The period and/or number of days between the last freeze in the spring and the first frost in the fall for the freeze threshold temperature of the crop or other designated temperature threshold. (2) Also, the average number of days exceeding 32°F (0°C).

Growler — (Oceanography) A small piece of floating ice, less than 10 meters across and barely showing above water.

Growth Management Program — A program comprised of several techniques to coordinate public and private decisions about the location and timing of development in order to best utilize environmental and physical resources.

Growth Water — The portion of total soil water available to plants for growth.

GSU — Geographically Separated Unit.

Gush — To flow forth suddenly in great volume.

Gulf — A portion of an ocean or sea extending into the land; a partially landlocked sea, usually larger than a bay.

Gulf Stream — (Oceanography) (1) The warm ocean current of the North Atlantic Ocean. It originates in the *Westward Equatorial Current* caused by the trade winds, but is deflected northward by the coast of South America into the Gulf of Mexico; issuing thence, it follows approximately the coast of North America to the island of Nantucket, where it is deflected more to the eastward. Its influence is felt as far as Norway. Where it issues from the Gulf of Mexico, its velocity is more than four miles per hour, but in much of the northern part of the Atlantic Ocean its velocity is only 10 to 15 miles per day. (2) The well-defined western boundary current of the North Atlantic Ocean, which carries warm, saline tropical water north and northeastward along the eastern coast of the United States, joining the *Labrador Current* at the Grand Banks, about 40 degrees north latitude and 50 degrees west longitude, to become the *North Atlantic Current*. The Gulf Stream generally swift and deep and transports a considerable volume of water. See *Ocean Current*.

Gulf Stream Countercurrent — (Oceanography) (1) Any of several currents running counter to the *Gulf Stream*, on either side of it at different locations. (2) A predicted large undercurrent beneath the Gulf Stream, observations of which are still inconclusive. See *Ocean Current*.

Gulf Stream Eddy — (Oceanography) A detached body of water that has broken off from a meander of the *Gulf Stream*, noticeable because of its differences from the water surrounding it. See *Ocean Current*.

Gulf Stream Front — (Oceanography) The sharp horizontal gradient of temperature characteristic of the *Gulf Stream*, frequently displaying a change of 10°C over distances of only a few hundred meters.

Gulf Stream Meander — (Oceanography) One of the many variable windings that the *Gulf Stream* makes, especially as it becomes the North Atlantic Current, persisting a few days or weeks.

Gulf Stream System — (Oceanography) A collective term for the Florida Current, *Gulf Stream*, and North Atlantic Current.

Gully, also Gulley — (1) A channel or miniature valley cut by concentrated runoff but through which water commonly flows only during and immediately after heavy rains or during the melting of snow; may be *Dendritic* or branching or it may be linear, rather long, narrow, and of uniform width. (2) A small valley or gulch. The distinction between *Gully* and *Rill* is one of depth. A gully is sufficiently deep that it would not be obliterated by normal tillage operations, whereas a rill is of lesser depth and would be smoothed by ordinary farm tillage.

Gully Erosion — The widening, deepening, and headcutting of small channels and waterways due to erosion; severe erosion in which trenches are cut to a depth greater than 30 centimeters (approximately one foot). Also see *Erosion*.

Gully Reclamation — Projects designed to prevent erosion in gullies by either filling them in or planting vegetation to stabilize the banks. May include the use of small dams of manure and straw, earth, stone, or concrete to collect silt and gradually fill in channels of eroded soil.

Gumbo — A fine, silty soil, common in the southern and western United States, that forms an unusually sticky mud when wet.

Gun-Perforating — The process of perforating casing and cement in a well by shooting steel bullets or shaped charges through them.

Gurgitation — A whirling or surging motion, as of water.

Gut — (1) A narrow water passage, channel, or tidal stream connecting two bodies of water. (2) A channel created by water in motion that is deeper than the surrounding, shallower water.

Guttation — The loss of water in liquid form from the uninjured leaf or stem of the plant, principally through water stomata (the microscopic opening in the epidermis of plants, surrounded by guard cells and serving for gaseous exchange); the exudation of water from leaves as a result of root pressure.

Gutter — (1) A channel at the edge of a street or road for carrying off surface water. (2) A trough fixed under or along the eaves of a building for draining rainwater from a roof. (3) A furrow or groove formed by running water.

Guzzler — A manmade water collecting device used in wildlife management. In a typical configuration, the guzzler is constructed of a large impervious surface, say a plastic apron, which catches precipitation and feeds it into a storage container. An opening is then provided in the container which allows access to wildlife to drink.

GW — Groundwater (Ground Water).

GWDR — Ground Water Disinfectant Rule.

GWUDI — Ground Water Under Direct Influence (of surface water).

Gymnosperms (Gymnospermae) — (Botanical) One of the two classes within the plant family *Spermatophyta*, or seed plants, the other being *Angiosperms (Angiospermae)*. Gymnosperms are of lower phylogenetic rank, as they includes plants having the seeds naked, or not enclosed in an ovary. This class includes the extinct orders (sub-classes) *Bennettitales* and *Cordaitales*, and the orders *Cycadales*, *Ginkgoales*, *Gnetales*, and *Pinales*. Also see *Angiosperms*.

Gypsum — A natural hydrated (water attached) calcium sulfate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

Gyre — (Oceanography) (1) One of the six great circular current systems found above and below the equator in the Indian, Pacific,

and Atlantic Oceans. (2) A closed circulation system, ranging in size from a few hundred meters to thousands of kilometers. See *Ocean Current*.

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Haar — (Meteorology) A thick, wet sea fog characterized by fine drizzle that occurs in the coastal districts of eastern Scotland and northeastern England, usually in the summertime.

Habitat — (Ecology) (1) The place where an organism normally lives. A living place, including provisions for life. (2) A place where the physical and biological elements of ecosystems provide a suitable environment including the food, cover, and space resources needed for plant and animal livelihood. (3) The native environment or specific surroundings where a plant or animal naturally grows or lives. The surroundings include physical factors such as temperature, moisture, and light together with biological factors such as the presence of food or predator organisms. (4) The native environment of an animal or plant, or the kind of place that is natural for an animal or plant. The term can be employed to define surroundings on almost any scale from marine habitat, which encompasses the oceans, to microhabitat in a hair follicle of the skin.

Habitat Conservation Plan (HCP) — A requirement under the *Endangered Species Act (ESA)* when economic development may result in harm to *Threatened* or *Endangered Species*. The plan does allow for some loss of individual animals or habitat of a species in exchange for a commitment that will insure long-term survival. Its intent is to better balance economic development and conservation.

Habitat Indicator — A physical attribute of the environment measured to characterize conditions necessary to support an organism, population, or community in the absence of pollutants, e.g., salinity of estuarine waters or substrate type in streams or lakes.

Habitat Integrity — The condition of the physical habitat (banks, sediment) of a water body, particularly with respect to its suitability for aquatic life. The integrity condition is generally based on a comparison to a reference which is a relatively undisturbed system and represents the best quality to be expected for the *Ecoregion*.

Habitat Type — A collective term for all land areas potentially capable of supporting the same climax, biotic community.

Hadal — (Oceanography) Of or relating to the greatest depths of the ocean, the trenches over 6 kilometers deep. Also referred to as the *Hadal Zone*.

Hail — (Meteorology) (1) Solid ice precipitation that has resulted from repeated cycling through the freezing level within a *Cumulonimbus Cloud*. (2) Precipitation which forms into balls or lumps of ice over 0.2 inch (5 mm) in diameter. Hail is formed by alternate freezing and melting as it is carried up and down by turbulent air currents within a cloud. (3) Small balls or chunks of ice having diameters that range from 0.2 to 3+ inches (5 to 75+ mm) and fall from thunderstorms. (4) Any precipitation that freezes in concentric layers about a core as vertical air currents drop and lift it; its diameter is always greater than 5 mm, larger than ice or snow pellets. Hail is formed by convective clouds that are usually cumulonimbus, and is often associated with thunderstorms. Thus, hailstorm.

Hail Stage — (Meteorology) A thermodynamic process of freezing suspended water drops in an *Adiabatic Atmosphere* in which rising air is cooled below the freezing point, with the assumption that the latent heat of fusion maintains a constant temperature until all available moisture is frozen; formerly used as a model for the formation of hail.

Hailstone — (Meteorology) (1) A hard pellet of snow and ice. (2) A pellet of hail, typically 1/4 inch to 6 inches in diameter, having a shape that is spheroidal, conical, or generally irregular.

Hailstorm — A storm with *Hail*.

Hail Suppression — Any method of reducing the damaging effects of hailstorms by modifying the characteristics of the hail-producing cloud. The currently prevailing hypothesis is that silver iodide seeding provides more hailstone nuclei (and, at the same time, reduces the amount of supercooled water available to build up large hailstones) with the net effect that the hail that reaches the ground is smaller and less damaging, and also has a high probability of melting before reaching the ground.

Hair — (River) Fast, extremely turbulent water covered with white, aerated foam. Also see *Smoker*.

Hair Hygrometer (Hygrograph) — An instrument for measuring humidity which makes use of the fact that the length of hair varies with relative humidity.

Halcyon Days (Water) — With respect to water, generally refers to idyllic by-gone days when supplies of an area's fresh water was relatively abundant with respect to the demands of man.

Half-Flow Interval — The shortest period of time in days during which one-half of the annual runoff occurs.

Half-Life — (1) The length of time required for the mass, concentration, or activity of a chemical or physical agent to be reduced by one-half. (2) A term expressing the rate of radioactive decay of an element. It is the length of time required for half the material present to undergo spontaneous conversion to other elements.

Haline — Term used to indicate dominance of ocean salt.

Haline Marshes — A saturated, poorly drained area, intermittently or permanently water covered, having aquatic and grasslike vegetation, influenced predominately by ocean salts.

Halmeic — (Geology) describing a mineral or deep-sea sediment derived directly from sea water or formed around an organic nucleus.

Halo — (Meteorology) (1) A circular band of colored light around a light source, as around the sun or moon, caused by the refraction and reflection of light by ice particles suspended in the intervening atmosphere. (2) A colored ring or arc seen around the sun

or moon caused by light refracting and reflecting through ice crystals in the air. (3) An arc or ring of light that appears around the sun or the moon, caused by the reflection or refraction of light by ice crystals suspended in the earth's atmosphere, and exhibiting whitish luminosity or prismatic coloration, with red nearest the inside and blue at the outside. Also see *Rainbow* for a similar refraction and reflection principal using water.

Halocline — (Oceanography) (1) A well-defined and usually positive vertical gradient of *Salinity*. (2) The boundary between surface fresh water and underlying saltwater in a stratified coastal environment. A location where there is a marked change in salinity.

Halogen — One of the chemical elements chlorine, bromine, or iodine.

Halophytes — A group of salt-tolerant plants ranging from cacti to sea grass that can absorb salt and heavy metals such as cadmium and arsenic from the wastewater of power plants, particularly coal-fired generating plants which is typically laden with heavy-metal byproducts of coal combustion.

Halosere — (Ecology) An ecological succession that begins in a saline environment.

Halosphere — (Ecology) The marine portion of the environment. Also refers to saltwater areas as a whole.

Hammock (also Hummock) — (1) In the southern United States, especially Florida, an area characterized by hardwood vegetation, the soil being of a greater depth and containing more humus than that of the flatwoods or pinelands, hence being more suitable for cultivation. Particularly, a tract of forested land that rises above an adjacent marsh. (2) A ridge or hill of ice in an ice field. See *Hummock*.

Hanging Tributary — A tributary stream that enters a main canyon over a waterfall. The tributary canyon mouth is on the wall of the main canyon rather than at river level. Also see *Hanging Valleys*.

Hanging Valley — (Geology) A tributary *Glacial Valley* whose mouth opens above the floor of the main valley. Hanging valleys can be created when smaller tributary glaciers join the main ice sheet. Since the main glacier is larger and heavier than the tributary one(s), the main glacier will erode more deeply into its valley than will the tributary into its own valley. After the ice melts, the tributary valley will be left hanging part of the way up the wall of the larger canyon that it intersects. Many waterfalls in the high Sierras, including well-known ones at Yosemite National Park, occur at the juncture of a hanging valley with a larger canyon. Also see *Hanging Tributary*.

Harbor — A sheltered anchorage for ships and boats. Also see *Port*.

Hard — See *Hard Water*.

Hard Rime — See *Rime*.

Hard Water — (1) Water which forms a precipitate with soap due to the presence of calcium, magnesium, or ferrous ions in solution. (2) Alkaline water containing dissolved salts that interfere with some industrial processes and prevent soap from lathering. Water may be considered hard if it has a hardness greater than the typical hardness of water from the region. Some textbooks define hard water as water with a hardness of more than 100 mg/L as calcium carbonate. Contrast with *Soft Water*.

Hardness (Water) — (1) A property of water causing formation of an insoluble residue when the water is used with soap. It is primarily caused by calcium and magnesium ions. (2) A measure of the amount of calcium and magnesium salts in water. More calcium and magnesium lead to greater hardness. The term "hardness" comes from the fact that it is hard to get soapsuds from soap or detergents in hard water. This happens because calcium and magnesium react strongly with negatively charged chemicals like soap to form insoluble compounds. (3) A characteristic of water which describes the presence of dissolved minerals. Carbonate hardness is caused by calcium and magnesium bicarbonate; noncarbonate hardness is caused by calcium sulfate, calcium chloride, magnesium sulfate, and magnesium chloride. (4) A property of water which causes an increase in the amount of soap that is needed to produce foam or lather and that also produces scale in hot water pipes, heaters, boilers and other units in which the temperature of water is increased materially. Hardness is produced almost completely by the presence of calcium and magnesium salts in solution. Also see *Soft Water*. The following scale may assist in appraising water hardness, measured by weight of dissolved salts (in milligrams) per unit of volume (in liters) of water:

Hardness Measure	Weight Dissolved Salts
Soft	0-60 milligrams/liter (mg/L)
Moderately Hard	61-120 mg/L
Hard	121-180 mg/L
Very Hard	over 180 mg/L

Hardpan — (1) A layer of nearly impermeable soil beneath a more permeable soil, formed by natural chemical cementation of the soil particles. (2) A hard impervious layer composed chiefly of clay or organic materials cemented by relatively insoluble materials, which does not become plastic when wet, and definitely limits the downward movement of water and roots.

Harmful Algal Blooms (HABs) — A condition in aquatic environments resulting from excessive nutrient loadings which lead to excessive growth of *Macrophytes* or *Phytoplankton*. This, in turn, leads to oxygen declines, an imbalance of prey and predator species, public health concerns, and a general decline of the aquatic resource. When nutrient inputs exceed the *Assimilative Capacity* of a waterbody system, the system progresses toward *Hypereutrophic* conditions. Symptoms include an overabundance of primary producers, decreased biological diversity, *Algal Blooms* (some toxic), low dissolved oxygen, episodic anoxia, loss of vascular plant life, and fish kills. Investigations have shown that the key causative factors of HABs are excessive concentrations of the primary nutrients phosphorus and nitrogen. Federal HAB programs, conducted under the National Harmful Algal Bloom Research and Monitoring Strategy, are spread across a number of federal agencies, including:

- *National Oceanic and Atmospheric Administration (NOAA)*;

- U.S. Environmental Protection Agency (EPA);
- Department of Health and Human Services (DHHS), including Centers for Disease Control and Prevention (CDCP), the Food and Drug Administration (FDA), and the National Institute of Environmental Health Sciences (NIEHS);
- National Biologic Service (NBS);
- National Science Foundation (NSF); and
- U.S. Fish and Wildlife Service (USFWS).

Also see *Ecosystem Stress*.

Harmonic Constituent — (Oceanography) Any of the various quantities in a mathematical expression of the tide-producing force, principally the variable tide-producing forces of the sun and moon. Also referred to as *Harmonic Tidal Constituent*, *Partial Tide* or *Tidal Component*.

Harmonic Prediction — (Oceanography) A method of predicting tides and tidal currents by combining all harmonic constituents into a single tide curve.

Harvested Rainwater — The rain that falls on a roof or yard and is channeled by gutters or channels to a storage tank. The first wash of water on a roof is usually discarded and the subsequent rainfall is captured for use if the system is being used for potable water.

Haud — (Meteorology) A term used in Scotland to denote a squall.

Haystack — A vertical standing wave in turbulent river waters. A large standing wave caused by the deceleration of a river's current.

Hazard Adjustment — See *Structural Floodplain Management Measures* and *Nonstructural Floodplain Management Measures*.

Hazard Mitigation — Action taken to reduce or eliminate long-term risk to people and property from hazards such as floods, earthquakes, and fires.

Hazard Ranking System (HRS) [EPA] — A method for ranking hazardous waste disposal sites for possible placement on the *National Priorities List (Superfund List)*, as provided for by the *Comprehensive, Environmental Response, Compensation, and Liability Act (CERCLA)*. The ranking uses information gathered by the preliminary assessment and site inspection and the listing site inspection. The need for remedial action is scored on the basis of potential harm to human health resulting from: (1) releases into groundwater, surface water, or the atmosphere; (2) fire and explosion; and/or (3) direct contact with hazardous materials. The HRS evaluation assigns an overall numerical value to each site, which determines its priority for cleanup. Also see *Hazardous Substance* and *Hazardous Substances Superfund*.

Hazardous Material [EPA] — A substance, pollutant or contaminant listed as hazardous under the *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* of 1980, as amended, and the regulations promulgated pursuant to that act.

Hazardous Substance — (1) Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive. (2) Any substance designated by the U.S. Environmental Protection Agency (EPA) to be reported if a designated quantity of the substance is spilled in the waters of the United States or if otherwise released into the environment. Also referred to as *Hazardous Waste*.

Hazardous Substances Superfund [EPA] — A federal trust fund for use in the cleanup of spills or sites containing hazardous waste that pose a significant threat to the public health or the environment. The fund, originally called the *Hazardous Substances Response Trust Fund*, was established by the *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* in 1980. Beginning that year \$1.5 billion was to be collected over five years, mainly from taxes on crude oil, petroleum products, petrochemicals, and certain inorganic chemicals. The 1986 re-authorization of the law, which changed the fund's name to the *Hazardous Substances Superfund* (or just "Superfund"), increased the fund to \$8.5 billion and broadened the tax base to include a general corporate Superfund tax. Another one-half billion dollars was included to clean up leaks from underground storage tanks. Also see *U.S. Environmental Protection Agency (EPA)*.

Hazardous Waste — Solid, liquid, or gaseous substances which because of their source or measurable characteristics, are classified under state or federal law as potentially dangerous and are subject to special handling, shipping, and disposal requirements. Also see *Hazardous Substance*.

Haze — Atmospheric moisture, dust, smoke, and vapor that diminishes visibility.

Haze Droplet — (Meteorology) (1) Any small droplet of liquid that contributes to an atmospheric haze condition. (2) An intermediate state between a condensation nucleus and a cloud or fog drop.

Head — (1) Energy contained in a water mass, produced by elevation, pressure, or velocity. (2) The vertical distance (in feet) equal to the pressure (in pounds per square inch, or psi) at a specific point. In this regard, the *Pressure Head* is equal to the pressure in psi times 2.31 ft/psi. (3) The difference in elevation between intake and discharge points for a liquid. (4) (Oceanography) The end of a rip current as it widens seaward of the breaker zone. (5) (Geology) Pressure or elevation differences in connection with the movement of underground water.

Head Cut — A break in slope at the top of a gully or section of gully that forms a "waterfall," which in turn causes the underlying soil to erode and the gully to expand uphill.

Head Cutting — (1) The action of a bedscarp or headward erosion of a locally steep channel or gully. (2) A natural process of active erosion in a water channel caused by an abnormal and abrupt change in channel gradient. This change causes a "waterfall" action as water tumbles from the upper level vertically to the lower. The turbulence erodes the channel by undercutting the substrate material. This causes the collapse of the upper level (head). The "undercut-collapse" process advances up the channel whenever water is present or until bedrock is reached.

Head Ditch — The water supply ditch at the head end of an irrigated field.

Head Loss — (1) The decrease in total head caused by friction. That part of head energy which is lost because of friction as water

flows. (2) The effect of obstructions, such as narrow bridge openings or buildings, that limit the area through which water must flow, raising the surface of the water upstream from the obstruction. (3) The head, pressure, or energy (they are the same) lost by water flowing in a pipe or channel as a result of turbulence caused by the velocity of the flowing water and the roughness of the pipe, channel walls or restrictions caused by fittings. Water flowing in a pipe loses head, pressure or energy as a result of friction losses. (4) The head loss through a filter is due to friction losses caused by material building up on the surface or in the top part of a filter. (5) An indirect measure of loss of energy or pressure. Flowing water will lose some of its energy when it passes through a pipe, bar screen, comminutor, filter or other obstruction. The amount of energy or pressure lost is called "head loss." Head loss is measured as the difference in elevation between the upstream water surface and the

downstream water surface and may be expressed in feet or meters. Also see *Friction Losses*.

Head, Static — The height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point. The static head is the sum of the *Elevation Head* and the *Pressure Head*.

Head, Total — The sum of the *Elevation Head* (distance of a point above datum), the *Pressure Head* (the height of a column of liquid that can be supported by static pressure only at the point), and the *Velocity Head* (the height to which the liquid can be raised by its own kinetic energy). Also see *Hydraulic Head*.

Head Wall — A steep slope or precipice rising at the head of a valley or glacial *Cirque*.

Header — (1) A pipe that serves as a central connection for two or more smaller pipes. (3) A large pipe to which a series of smaller pipes are connected. Also called a manifold. (3) A raised tank or hopper that maintains a constant pressure or supply to a system, especially the small tank that supplies water to a central heating system.

Headgate — The gate that controls water flow into irrigation canals and ditches; the control works or gate at the entrance to a canal or conduit system. A watermaster regulates the headgates during water distribution and posts headgate notices declaring official regulations. Headgate also refers to a diversion structure which controls the flow rate from a conveyance system (canals and laterals) into the farm conveyance system.

Headgate Entitlement — The amount of water (expressed in acre feet per year) to which a particular water right is entitled.

Headland — (1) A point of land, usually high and with a sheer drop, extending out into a body of water; a promontory. (2) The unplowed land at the end of a plowed furrow.

Headrace — A channel that carries water to a water wheel or turbine; a forebay.

Headslope — See *Sideslope*.

Headstream — A stream that is the source or one of the sources of a larger stream or river.

Headwall — (1) (Geology) A steep slope at the head of a valley, especially the rock cliff at the back of a *Cirque*. (2) (Civil Engineering) A retaining wall at the outlet of a drain or culvert serving as protection against scouring or undermining of fill or as a flow-diverting device.

Headward Erosion — (Geology) (1) The lengthening of a valley or gulley, or of a stream, by erosion at the valley head. (2) Erosion which occurs in the upstream end of the valley of a stream, causing it to lengthen its course in that direction. Also referred to as *Head Erosion* or *Headwater Erosion*.

Headwater(s) — (1) The source and upper reaches of a stream; also the upper reaches of a reservoir. (2) The water upstream from a structure or point on a stream. (3) The small streams that come together to form a river. Also may be thought of as any and all parts of a river basin except the mainstream river and main tributaries. Also see *Headstream*.

Headworks — (1) The diversion structures at the head of a conduit. (2) The facility at the "head" of the water source where water is first treated and routed into the distribution system. (3) (Wastewater Treatment) The facilities where wastewater enters a wastewater treatment plant. The headworks may consist of bar screens, comminutors, a wet well and pumps.

Health Advisory [EPA] — A U.S. Environmental Protection Agency (EPA) document that provides guidance and information on contaminants that can affect human health and that may occur in drinking water, but which EPA does not currently regulate in drinking water.

Health Advisory Level — A non-regulatory health-based reference level of chemical traces (usually in parts per million, ppm) in drinking water at which there are no adverse health risks when ingested over various periods of time. Such levels are established for one day, 10 days, long-term and life-time exposure periods. They contain a wide margin of safety.

Health Hazards — Any condition, including any device or water treatment practice, that may create an adverse effect on a person's well-being.

Healthy Ecosystem — An *Ecosystem* in which structure and functions allow the desired maintenance over time of biological diversity, biotic integrity, and ecological processes.

Heap Leaching (Mining) — Heap leaching is a chemical process used to extract precious and other metals from vast amounts of earth and rock material. Tiny gold and silver particles dispersed throughout massive ore bodies can be economically recovered by leaching operations. However, due to the reactive nature of the chemicals used, environmental hazards may be created if care is not taken. Large quantities of naturally-occurring heavy metals and mineral salts are exposed and concentrated through this mining process. In the case of gold mining, a dilute cyanide solution is sprinkled over heaps of crushed rock, underlain by synthetic liners. The cyanide chemically bonds with the microscopic gold particles, which are then collected at the bottom of the heap in plastic liners for further processing. When the gold has been removed by this process, the heaps become a waste product requiring management and control well into the future. Heaps are typically full of residual dilute cyanide solution which, along with precipitation directly on the heap, will continue to drain through the heap. Because the heaps may contain residual cyanide, selenium, arsenic, mercury and various salts, the drainage solution may be hazardous to surface and groundwater supplies and the environment. Quite often, the least-costly manner in which to dispose of this continuous heap drainage is through a leach field and into the ground, where it may have adverse effects on the quality of groundwater, potentially contaminating water supplies for agriculture, human consumption and wildlife.

Heat Budget, Annual (of a Lake) — The amount of heat necessary to raise the water from the minimum winter temperature to the maximum summer temperature.

Heat Engine Cycle — The process by which heat transferred from fuel combustion products to a working fluid (steam) is partially converted to mechanical work by expansion of the steam in an engine (turbine). The useless heat energy remaining in the exhaust steam is discarded by condensing it with cooling water.

Heat Exchangers — Any mechanical device designed to transfer heat energy from one medium to another. In many such exchangers water is used as the primary medium of transfer.

Heat of Hydration — The heat evolved during the setting and hardening of Portland cement or cement grout.

Heat of Condensation — The heat released when a vapor changes state to a liquid. See *Heat of Vaporization*.

Heat of Vaporization — The heat energy (calories) required to convert one gram of liquid to vapor without a change in temperature of the substance which is being vaporized. For water at 100EC (212EF) and standard atmospheric pressure, the heat of vaporization is 540 calories per gram. Conversely, when a liquid condenses, it loses the heat absorbed upon vaporization, giving off *Heat of Condensation*.

Heat Pump — An apparatus for heating or cooling a building by transferring heat by mechanical means from or to a reservoir (as the ground, water, or air) outside the building.

Heat Sink — Any material used to absorb heat. In the environment, this is usually air or water that absorbs waste heat produced in the operation of electric power plants or other industrial facilities.

Heat Storage — (Oceanography) The action of the ocean as a heat reservoir, moderating the daily and seasonal temperature variations over the sea.

Heat Transfer Agent — A liquid or gas that functions in a *Heat Exchanger* to facilitate the movement of heat from one location to another. For example, the engine coolant in an automobile serves to transfer heat from the engine block to the atmosphere. Likewise, water facilitates the movement of heat from the reactor core to the outside of a nuclear reactor.

Heat Thunderstorm — (Meteorology) A popular term for a *Convective Thunderstorm* occurring at the end of a hot and humid summer day.

Heath — A tract of waste land; especially in Great Britain, an open, level area clothed with a characteristic vegetation consisting principally of undershrubs of the genus *Erica*, or a large genus of low evergreen shrubs. Also see *Peatland*.

Heave — (1) (Oceanography) The vertical and horizontal movement caused in a floating body by wave action. (2) (Geology) A predominantly upward expansion or displacement of a soil surface, caused by swelling clay, overloading of an embankment, seepage pressure, or frost action.

Heavy Floe — (Oceanography) An ice floe that is more than 3 meters (6 feet) thick. Also referred to as *Heavy Ice*.

Heavy Metals — (1) Metallic elements with high atomic weights, e.g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain. (2) Those metals that have high density; in agronomic usage these include copper, iron, manganese, molybdenum, cobalt, zinc, cadmium, mercury, nickel and lead. These substances are considered toxic at specified concentrations. (3) Metals having a specific gravity of 5.0 or greater; generally toxic in relatively low concentrations to plant and animal life and tend to accumulate in the food chain. Examples include lead, mercury, cadmium, chromium, and arsenic.

Heavy Snow — As defined by the *National Weather Service (NWS)*, snowfall accumulations of 6 inches (15 cm) or more in 12 hours, or 8 inches (20 cm) or more in 24 hours. These criteria are specific for the Midwestern United States and may vary regionally.

Heavy Snow Warning — A warning issued by the *National Weather Service (NWS)* when snowfall of 6 inches (15 cm) or more in 12 hours or 8 inches (20 cm) or more in 24 hours is imminent or occurring. These criteria are specific for the Midwestern United States and may vary regionally.

Heavy Water (River) — Fast current, large waves, usually associated with holes, boulders, and general turbulence. See *Big Water*.

Heavy Water (Chemical) — Water composed of isotopes of hydrogen of atomic weight greater than 1 or of oxygen of atomic weight greater than 16, or both; especially water composed of ordinary oxygen and the isotope of hydrogen of atomic weight 2; *Deuterium Oxide* (D₂O). Typically used as a moderator in certain nuclear reactors. Also see *Heavy Water Moderated Reactor*.

Heavy Water (Moderated) Reactor — A nuclear reactor that uses heavy water as its moderator. Heavy water is an excellent moderator and thus permits the use of inexpensive (unenriched) uranium as a fuel.

Hectare — (Abbreviation ha) A measure of area in the metric system similar to an acre. One hectare is equal to 10,000 square meters (107,639 square feet), and 100 *Ares* (2.4711 acres). Also see *Metric System*.

Height — The difference in the elevation of either the natural bed of the stream or watercourse or the lowest point on the toe of the dam, whichever is lower, and the crest elevation of the dam.

Helicity — A property of a moving fluid which represents the potential for helical (corkscrew-like) flow. Higher values of helicity favor the formation of rotation in thunderstorms which typically results in a greater chance for severe weather.

Hemihydrate — A hydrate in which the molecular ratio of water molecules to anhydrous compound is 1:2.

Hemipelagic Sediment — (Geology) A deep-sea deposit containing a small amount of terrestrial material, as well as the remains of *Pelagic* organisms.

Hepatitis — Inflammation of the liver. A virus-caused disorder transmitted to humans by the consumption of raw oysters taken from water contaminated with sewage.

Hepatitis A — A form of hepatitis caused by an RNA virus that does not persist in the blood serum and is transmitted by ingestion of infected food and water. The disease has a shorter incubation and generally milder symptoms than *Hepatitis B*. Also referred to as *Infectious Hepatitis*.

Herbaceous — With the characteristics of an herb; having the texture and color of a foliage leaf; a plant with no persistent woody stem above ground.

Herbicide — (1) A compound, usually a man-made organic chemical, used to kill or control plant growth. (2) Chemicals used to destroy undesirable plants and vegetation. Pre-emergent herbicides, applied to bare soil, prevent germination of weed seeds. (3) A substance or preparation for killing plants, and especially weeds.

Herding Agent — A chemical applied to the surface of water to control the spread of a floating oil spill.

Heterogeneity — Characteristic of a medium in which material properties vary from point to point. Contrast with *Homogeneity*.

Heterogeneous — Nonuniform in structure or composition throughout.

Heterotrophic — Pertains to a system in which respiratory demand exceeds *Photosynthesis*. In a heterotrophic system biological fertility is based upon past production, organic matter accumulation and material imported from other systems (e.g., *Allochthonous Material* falling from terrestrial systems into aquatic systems.)

Heterotrophic Bacteria — Bacteria which require organic carbon as a source of energy for life processes.

Heterotrophic Microorganisms — Bacteria and other microorganisms that use organic matter synthesized by other organisms for energy and growth.

Heterotrophic Plate Count (HPC) — (1) A test performed on drinking water to determine the total number of all types of bacteria in the water. (2) The number of colonies of *Heterotrophic Bacteria* grown on selected solid media at a given temperature and incubation period, usually expressed in number of bacteria per milliliter of sample. Often used as an indicator of water quality.

Heterotrophic Plate Count Bacteria — A broad group of bacteria including nonpathogens, pathogens, and opportunistic pathogens that may be an indicator of poor general biological quality of drinking water.

Hexagonal Column — (Meteorology) One of many forms of ice crystals that are found in the atmosphere, characterized by a hexagonal cross section in a plane perpendicular to the length of the column.

Hexagonal Platelet — (Meteorology) A small ice crystal of hexagonal tabular form, in which the distance from one side to the other is 10 times as great as the thickness perpendicular to this dimension; it forms at temperatures of -10 to -20EC by the process of sublimation.

Hierarchical — (Ecology) A description of *Ecosystems* referring to their nested and scale-dependent organization.

High Clouds — (Meteorology) A class of clouds consisting of those that occur at altitudes higher than 20,000 feet above sea level, including the *Cirrus*, *Cirrostratus*, and *Cirrocumulus* cloud types.

High-Energy Environment — (Geology) An aqueous sedimentary environment characterized by a high level of kinetic energy from currents, waves, or surf, and turbulent activity that prevents fine-grained sediments from settling and accumulating.

High Fog — (Meteorology) A type of fog that occurs frequently along the slopes of the California coastal mountains, when moist air overruns the peaks of the mountains and extends as low-level stratus clouds in the leeward valleys.

High-Grading — (Ecology) A harvesting practice in which the most valuable trees are removed with little provision for regeneration or subsequent entries.

High-Hazard Dam — A dam whose failure may cause loss of life.

High-Level Thunderstorm — (Meteorology) A thunderstorm based at an altitude of approximately 8,000 feet or higher above the earth's surface that occurs dramatically over desert areas; its precipitation often evaporates before reaching the surface.

High-Line Jumpers — Pipes or hoses connected to fire hydrants and laid on top of the ground to provide emergency water service for an isolated portion of a distribution system.

High-Moor Bog — (Ecology) A *Bog* that is not dependent on the *Water Table* and whose surface is covered by moss.

High Sea — The open part of a sea or ocean, especially outside territorial waters; usually used in plural.

High Tide (HT) — (1) The tide at its fullest extent, when the water reaches its highest level. (2) The time at which this tide occurs. The high-high and low-high tides are the higher and lower of the two high tides, respectively, of each tidal day.

High Tide [United States, 33 CFR 328.3(d)] — The term "high tide" line means the line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency, but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

High Water (HW) — (1) High tide. (2) The state of a body of water that has reached its highest level.

High Water Mark (HWM) — A mark indicating the highest level reached by a body of water.

High-Water Platform — See *Wave-Cut Bench*.

Higher Aquatic Plants — Those plants whose seeds germinate in the water phases or substrate of a body of water and which must spend part of their life cycle in water. Includes plants which grow completely submerged as well as a variety of emerged and floating leaf types.

"Highest and Best Use" — The classification of water based on an analysis of the greatest needs of the future. Certain quantities of water (rights) are reserved for appropriation according to this classification.

Highest Annual Mean — A value used for river flow readings representing the highest total annual volume (in acre-feet per year) and the corresponding highest annual average rate of flow (in cubic feet per second) recorded at a specific gaging station location over a specific period of record. Also referred to as the *High Water Year*.

Highland Glacier — An ice cap or glacier system that more or less covers the highest or central portion of a mountainous area and partly reflects the irregularities of the land surface underneath. Also referred to as *Highland Ice*.

Highland Ice — See *Highland Glacier*.

Histology — The study of the structure of cells and tissues; usually involves microscopic examination of tissue slices.

Historical Geomorphology — See *Geomorphology, Historical*.

Historic Variability — (Ecology) The variation in spatial, structural, compositional, and temporal characteristics of ecosystem elements during a reference period prior to intensive resource use and management. In the Southwest United States, this reference period is typically considered the recent climatic and ecological era before the territorial period (resource use and management by native and Hispanic cultures are integrated with other ecological process).

Histosols — Organic soils.

Hoar Crystal — Any of the ice crystals that form *Hoarfrost*.

Hoarfrost (or Hoar Frost) — (1) A silvery-white deposit of ice needles formed by direct condensation at temperatures below freezing due to nocturnal radiation. Hoarfrost forms during still, clear nights, is small in amount, needlelike in texture, the “needles” approximately perpendicular to the objects on which they occur, and most abundant along the edges. (2) A deposit of interlocking crystals formed by direct sublimation on objects, usually those of small diameter freely exposed to the air, such as tree branches, plants, wires, poles, etc. The deposition of hoar frost is similar to the process by which dew is formed, except that the temperature of the frosted object must be below freezing. It forms when air with a dew point below freezing is brought to saturation by cooling. Sometimes confused with *Rime*. Also see *Frost*.

Hogback Ridge — Any ridge with a sharp summit and steep slopes of nearly equal inclination on both flanks, and resembling in outline the back of a hog.

Hogshead — Any of various units of volume or capacity ranging from 63 to 140 gallons (238 to 530 liters), especially a unit of capacity used in liquid measure in the United States equal to 63 gallons (238 liters).

Holding Medium — (Water Quality) A special fluid employed for maintaining fecal bacteria in a viable state between the time that water samples are processed by filtration and the time that the filters used to remove the bacteria from water can be incubated properly. The medium protects viability between sampling and analysis.

Holding Pond — A small basin or pond designed to hold sediment laden or contaminated water until it can be treated to meet water quality standards or be used in some other way.

Holding Tank — A prefabricated structure of concrete or steel or like materials constructed to store liquid manure from animals.

Holding Time — (Water Quality) The time allowed between removal of samples from water sources for bacteriological analysis and the processing of those samples.

Hole — A deep place in a body of water.

Holistic — Of, concerned with, or dealing with wholes or integrated systems rather than with their parts. With respect to water-related issues, the term most typically describes an analytical and planning approach which examines and considers the inter-related linkages and interdependencies of a socioeconomic system with resource use, pollution, environmental impacts, and preservation of an entire ecosystem.

Holocene — (Geologic Time) (1) The time period from the close of the *Pleistocene* or glacial epoch through the present; synonymous with *Recent*. (2) The present epoch of time, beginning about 10,000 years ago. Also see *Quaternary*.

Holomictic Lake — A lake that undergoes a complete mixing of its waters throughout its entire depth during periods of circulation or *Overtum*.

Holothurian — A group of marine, bottom-dwelling animals related to the sea stars and sand dollars (echinoderms). Unlike these relatives, the holothurians have soft bodies and are long and slender in shape, such as the sea cucumber.

Homeohydric — (Ecology) Able to maintain approximately constant water content in the body under variable water conditions in the environment.

Homeostasis — (Ecology) The maintenance of a steady state by use of feedback control processes. In homeostatic systems, a change outside the normal range is seen as a decline in the health of that system.

Homeowner Water System — Any water system which supplies piped water to a single residence.

Homogeneity — Characteristic of a medium in which material properties are identical throughout. A material is homogeneous if its hydrologic properties are everywhere identical. Although no known aquifer is homogeneous in detail, models based on the assumption of homogeneity have proven to be valuable tools for predicting the approximate relationship in aquifers between discharge and potential. Contrast with *Heterogeneity*.

Homogeneous — Uniform in structure or composition throughout.

Homeohydric — (Ecology) Able to maintain approximately constant water content in the body under variable water conditions in the environment.

Homeowner Water System — Any water system which supplies piped water to a single residence.

Hookah — An Eastern smoking pipe designed with a long tube passing through an urn of water that cools the smoke as it is drawn through. Also referred to as a *Hubble-Bubble* and *Narghile*.

Hook Gage — A pointed, U-shaped hook attached to a staff or vernier scale, used in the accurate measurement of the elevation of a water surface. The hook is submerged, and then raised, usually by means of a screw, until the point just makes a pimple on the water surface.

Horizon (Soils) — Many soils are composed of layers possessing distinctive physical and chemical characteristics. These layers are known as horizons, and are commonly referred to by letter designations. Thus the “A” horizon may be weathered material nearest the surface, and the “C” horizon may be unconsolidated material with little chemical weathering lying adjacent to the underlying country rock.

Horizontal and Vertical Control Points — See *Control Points (Horizontal and Vertical)*.

Horizontal Closed-Loop System — A continuous length of sealed pipe that is installed in trenches or ditches with the ends connected to a water to air heat pump allowing the system to transfer heat from the ground to the liquid in the pipe or transfer heat from the liquid to the ground.

Horn — A body of land or water shaped like a horn.

Horsepower (Hp) — A unit of power, numerically equal to a rate of 33,000 foot-pounds of work per minute (or 550 foot-pounds per second), used in stating the power of an engine or any other prime mover, or in estimating the power required to drive machinery, or the like. The term horsepower was originated by Boulton and Watt to state the power of their steam engines. In a practical test it was found that the average horse could work constantly at a rate of 22,000 foot-pounds per minute. This was increased by one half (50 percent) in making this arbitrary, and now universal, unit of power. *Electrical Horsepower* is horsepower calculated from electric units whereby 746 watts of electrical energy is equivalent to one horsepower.

Horsepower, Electrical — Horsepower calculated from electric units whereby 746 watts of electrical energy is equivalent to one horsepower.

Horseshoe Lake — See *Oxbow Lake*.

Hose — (1) A flexible tube for conveying liquids or gases under pressure. (2) To water, drench, or wash with a hose.

Hose Bib Faucet — A location in a water line where a hose is connected.

Host — A living animal or plant that harbors or nourishes another organism.

Hostile Ice — (Oceanography) An ice canopy that does not present an outlet (such as a large ice skylight or other type of opening) for a submarine to surface.

Hot Rock Reservoir — A potential source of geothermal power. The “hot rock” system requires drilling deep enough to reach heated rock, then fracturing it to create a reservoir into which water can be pumped. This technique has not yet been perfected.

Hot Spring — (1) A thermal spring whose water temperature is higher than 98 degrees Fahrenheit (human body temperature); any spring whose water temperature is above the temperature of the human body. (2) A spring that brings hot water to the surface. A thermal spring. Water temperature usually 15EF (8EC) or more above the mean air temperature. Compare to *Warm Spring*.

House Boulder — A house-sized boulder in a river.

Hovercraft — A vehicle that is supported above the surface of land or water by a cushion of air produced by downwardly directed fans.

HPC — See *Heterotrophic Plate Count*.

Human Dimension — (Ecology) An integral component of *Ecosystem Management* that recognizes people are part of *Ecosystems*; that people’s pursuits of past, present, and future desires, needs, and values (including perceptions, beliefs, attitudes, and behaviors) have and will continue to influence ecosystems; and that ecosystem management must include consideration of the physical, emotional, mental, spiritual, social, cultural, and economic well-being of people and communities.

Human Ecology — (1) A branch of sociology dealing particularly with the spatial and temporal interrelationships between humans and their economic, social, and political organization; (2) The ecology of human communities and populations, especially as concerned with preservation of environmental quality (as of air or water) through proper application of conservation and civil engineering practices.

Human Environment — Natural and physical environment and the relationship of people with that environment including physical, biological, cultural, social, and economic factors in a given area.

Human Exposure Evaluation — A component of risk assessment that involves describing the nature and size of the population exposed to a substance and the magnitude and duration of their exposure. The evaluation could concern past exposures, current exposures, or anticipated exposures.

Human Health Risk — The likelihood (or probability) that a given exposure or series of exposures may have or will damage the health of individuals experiencing the exposures.

Humid — Containing or characterized by perceptible moisture. Usually refers to the atmosphere.

Humidity — (Meteorology) (1) A measure of the amount of water vapor, moisture, or degree of dampness in the air. (2) A popular term for *Relative Humidity*. Also see *Absolute Humidity*, *Specific Humidity*, and *Temperature-Humidity Index*.

Humidity Coefficient — (Meteorology) A measure of precipitation effectiveness in a particular region that takes into account the exponential relationship of air temperature versus plant growth; expressed as $P/(1.07)^t$, where “P” is the precipitation (in centimeters) and “t” is the mean temperature (in degrees Celsius) for a given period. From this relationship, each 10EC rise in the air temperature approximately doubles the denominator.

Humidity Index — (Meteorology) A mathematical index of the degree of water surplus over water need at a given site; used as a component of the moisture index and as a basis for the classification of dry climates.

Humidity Mixing Ratio — (Meteorology) The ratio of the mass of water vapor within a sample of moist air to the mass of the associated dry air, expressed as grams of water vapor per kilogram of air.

Humidity Province — (Meteorology) An area in which the precipitation effectiveness of the climate produces a particular biological consequence, particularly climatic climax forms of vegetation such as rainforest, tundra, or the like.

Humidor — (1) A device used to create moistened air for the storage of tobacco products. (2) A jar, case, room or storage area using such a device where tobacco products are stored.

Hummock — (1) A small but steep, irregular hill rising above the general level of the surrounding land; a low mound or ridge of earth, a knoll. (2) A tract of forested land that rises above an adjacent marsh in the southern United States. (3) A ridge or hill of ice in an *Ice Field*. (4) A mound or pile of broken, fresh, or weathered floating ice that has been forced upward by pressure. (Geology) (5) A conical or rounded, usually equidimensional mound, hillock, or other small elevation. (6) A frost mound. Also referred to as *Hammock*.

Hummocked Ice — (Oceanography) Pressure ice that is characterized by randomly arranged *Hummocks*, having less definite form than tented or rafted ice.

Hummocky — Hilly, uneven landscape resulting from deep-seated soil movement, usually of a rotational nature.

Humus — (1) Organic materials resulting from decay of plant or animal matter. Organic portion of the soil remaining after prolonged microbial decomposition. (2) A brown or black organic substance consisting of partially or wholly decayed vegetable

or animal matter that provides nutrients for plants and increases the ability of soil to retain water. Also referred to as *Compost*.
Humus Sludge — (Wastewater Treatment) The sloughed particles of biomass from trickling filter media that are removed from the water being treated in secondary clarifiers.

Hundred-Year Flood — The magnitude of a flood which has one chance in one hundred (i.e., one percent) of occurring in any one-year period. As the occurrence of floods is random in time, there is no guarantee that there will not be two one hundred-year floods within a given year, or that there will be one such flood within a given century (100 years). The boundary of the one hundred-year flood zone is used by the *Federal Emergency Management Agency (FEMA)* to designate *Special Flood Hazard Areas*. These areas are plotted on *Flood Insurance Rate Maps (FIRMs)*, which are used in determining the flood risk to structures in the *Flood Plain* for flood insurance purposes. Also see *X-Year Flood*.

Hungry Water — Clear water minus its expected suspended sediment, usually released from an impoundment that has excess energy, which erodes sediment from the downstream channel.

Hurricane — (1) A severe tropical cyclone originating in the equatorial regions of the Atlantic Ocean or Caribbean Sea, traveling north, northwest, or northeast from its point of origin, and usually involving heavy rains. (2) A wind with a speed greater than 74 miles (119 kilometers) per hour, according to the Beaufort scale. Also see *Cyclone* and *Typhoon*.

Hurricane Forecasting [NOAA] — (Meteorology and Statistics) Hurricane tracking and estimation in the United States is centered in the federal government's National Hurricane Center in Coral Gables, Florida. However, one pioneering effort in the application of statistical analysis and econometric techniques to hurricane analysis and forecasting has been undertaken by William Gray, professor of meteorology at Colorado State University in Fort Collins, Colorado. Dr. Gray's research is based on the foundation that hurricanes are caused by global, rather than local factors, to include the influence of *El Niño* (*El Niño Effect*, resulting in reduced hurricane activity as opposed to the *La Niña* when hurricanes tend to be more common) in the eastern equatorial Pacific Ocean as well as wind directions (pressure differentials) and precipitation levels. His research has led to an extensive quantitative expression to estimate both the number and intensity of hurricanes in the western Atlantic region (to include the Caribbean and Gulf of Mexico) during the usual peak hurricane season of mid-August through mid-October. The following relationship represents an *Econometric Model* for forecasting hurricane activity based upon a number of climatological explanatory factors covering a vast geographic range.

Hurricane Activity =

$$\begin{aligned} \beta_0 &+ \beta_1(\alpha_1 U_{50} + \alpha_2 U_{30} + \alpha_3 *U_{50} - U_{30} *) \\ &+ \beta_2(\alpha_4 R_s + \alpha_5 R_g + \alpha_6 \Delta_x P + \alpha_7 \Delta_x T) \\ &+ \beta_3(\alpha_8 SLPA + \alpha_9 ZWA + \alpha_{10} SST + \alpha_{11} \Delta_t SST + \alpha_{12} SOI + \alpha_{13} \Delta_t SOI) \end{aligned}$$

where:

- The β 's and α 's are empirically derived coefficients (parameters) for prior years of data;
- U_{50} and U_{30} are extrapolated September quasi-biennial oscillation (QBO – the tendency for equatorial winds 13 to 16 miles above the earth to change direction from east to west and vice versa) zonal winds at 30 and 50 mb at 10EN latitude;
- $*U_{50} - U_{30}*$ is the absolute value of the extrapolated vertical wind shear between 50 and 30 mb;
- R_s is the western Sahel (western portion of Africa's Sahara desert) precipitation in the previous August and September;
- R_g is the previous year August to November precipitation in the Gulf and Guinea region;
- ΔP is West African anomalous east-west pressure gradient deviation in February through May;
- ΔT is West African anomalous west-east temperature deviation in February through May;
- $SLPA$ is the April-May Sea Level Pressure Anomaly in the lower Caribbean basin;
- ZWA is the April-May Zonal Wind Anomaly in the Caribbean basin;
- SOI is the April-May normalized Tahiti minus Darwin Sea Level Pressure differences;
- $SSTA$ is the April-May Sea Surface Temperature Anomaly in Nino 3 (*El Niño*);
- ΔSOI is the recent months change in SOI from January-February to April-May;
- $\Delta SSTA$ is the recent months change in SSTA from January-February to April-May.

Husbandry — (Agriculture) The act or practice of cultivating crops and breeding and raising livestock. Also, the application of scientific principles to agriculture, especially to animal breeding. (Ecology) The careful management or conservation of resources.

Hyades — (Astronomy) A cluster of stars in the constellation Taurus, the five brightest of which form a V, supposed by ancient astronomers to indicate rain when they rose with the sun.

Hybrid System — A popular term for a system of water allocation incorporating both the *Doctrine of Prior Appropriation* and the *Riparian Doctrine*.

Hydathode — (Botany) A water-excreting microscopic epidermal structure in many plants.

Hydrant — A discharge pipe with a valve and spout at which water may be drawn from a water main (as for fighting fires) called also fireplug; (2) Faucet.

Hydrate — A solid compound containing water molecules combined in a definite ratio as an integral part of the crystal.

Hydrated — Chemically combined with water, especially existing in the form of a *Hydrate*.

Hydrated Lime — Limestone that has been burned and treated with water under controlled conditions until the calcium oxide portion has been converted to calcium hydroxide ($\text{Ca}(\text{OH})_2$). Hydrated lime is quicklime combined with water. $\text{CaO} + \text{H}_2\text{O} \div \text{Ca}(\text{OH})_2$.

Also see quicklime.

Hydration — (1) The chemical combination of water with another substance. (2) The act by which a substance takes up water by absorption and/or adsorption.

Hydraulic — (1) Of, involving, moved by, or operated by a fluid, especially water, under pressure. (2) Able to set and harden under water, as Portland cement. (3) Of or relating to hydraulics.

Hydraulic (River Characteristics) — *A Reversal*. This is a general term for reversals, eddy fences, and other places where there is a hydraulic gap, a powerful current differential in a river's flow. Sometimes used in the plural to refer to the whole phenomenon of big water, where massive waves, violent currents, and large holes are the principal navigational obstacles, rather than rocks.

Hydraulic Barrier — (1) Modifications to a ground-water flow system that restrict or impede movement of water and contaminants. (2) Also, a barrier developed in the *Estuary* by the release of fresh water from upstream reservoirs to prevent intrusion of sea water into the body of fresh water. (3) A barrier created by injecting fresh water to control seawater intrusion in an aquifer, or created by water injection to control migration of contaminants in an aquifer.

Hydraulic Block — The movement of water in such a way that the flow of water from one direction blocks or hinders the flow of water from another direction.

Hydraulic Collapse Resistance — The capability of well casing to withstand collapsing pressure under external loads.

Hydraulic Conductivity (K) — (1) Simply, a proportionality constant relating *Hydraulic Gradient* to *Specific Discharge*. The rate of flow of water in gallons per day through a cross-section of one square foot of medium under a unit hydraulic gradient (gpd/ft²). (2) Also, a coefficient of proportionality describing the rate at which water can move through an aquifer or other permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity. More specifically, the volume of water at the existing kinematic viscosity that will move, in unit time, under a unit *Hydraulic Gradient* through a unit area measured at right angles to the direction of flow, assuming the medium is isotropic and the fluid is homogeneous. In the Standard International System, the units are cubic meters per day per square meter of medium (m³/day/m²) or m/day (for unit measures).

Hydraulic Conductivity, Effective — The rate of water flow through a porous medium that contains more than one fluid (such as water and air in the unsaturated zone), which should be specified in terms of both the fluid type and content and the existing pressure.

Hydraulic Current — (Oceanography) A gravity flow of water through a channel, resulting from a tidally caused difference in the water levels at the two ends of the channel.

Hydraulic Discharge — The direct release of groundwater from the *Zone of Saturation* into a body of surface water or onto land.

Hydraulic Earthfill Dam — An embankment built up from waterborne clay, sand, and gravel carried through a pipe or flume.

Hydraulic Fracturing — Any technique involving the pumping of fluid under high pressure into an oil or gas formation to create fissures and openings in the reservoir rock and increase the flow of oil or gas.

Hydraulic Geometry — The interrelations between width, depth, velocity, and suspended load of a channel system and how these factors vary with discharge. These relations can be considered at a given station with varying discharge (at-a-station hydraulic geometry), or across many stations whose discharges are indexed at a fixed recurrence interval (downstream hydraulic geometry).

Hydraulic Grade Line (HGL) — (1) The surface or profile of water flowing out of hydraulic gradient. The slope of the hydraulic grade line is under pressure; the hydraulic grade line is at the level water would rise to in a small vertical tube connected to the pipe. (2) The surface or profile of water flowing in an open channel or a pipe flowing partially full. If a pipe is under pressure, the hydraulic grade line is at the level water would rise to in a small tube connected to the pipe. To reduce the release of odors from wastewater, the water surface or hydraulic grade line should be kept as smooth as possible. (3) A line whose plotted ordinate position represents the sum of pressure head plus elevation head for the various positions along a given fluid flow path, such as a pipeline or ground-water streamline. Also see *Energy Grade Line*.

Hydraulic Gradient (J) — (1) The slope of the water surface. (2) The rate of change in total head per unit of distance flow in a given direction. (3) The slope of the *Hydraulic Grade Line*. This is the slope of the water surface in an open channel, the slope of the water surface of the groundwater table, or the slope of the water pressure for pipes under pressure. (4) The gradient or slope of a water table or *Piezometric Surface* in the direction of the greatest slope, generally expressed in feet per mile or feet per feet. Specifically, the change in static head per unit of distance in a given direction, generally the direction of the maximum rate of decrease in head. The difference in hydraulic heads ($h_1 - h_2$), divided by the distance (L) along the flowpath, or, expressed in percentage terms:

$$I = (h_1 - h_2) / L \times 100$$

A hydraulic gradient of 100 percent means a one foot drop in head in one foot of flow distance.

Hydraulic Gradient Pivot Point — A location along the water surface in a canal reach where the water level remains essentially constant during changes in flow.

Hydraulic Head — (1) The height of the free surface of a body of water above a given point beneath the surface. (2) The height of the water level at the headworks or an upstream point of a waterway, and the water surface at a given point downstream. (3) The height of a hydraulic grade line above the center line of a pressure pipe, at a given point.

Hydraulic Jump — (1) The rapid change in the depth of flow from a low stage to a high stage, resulting in an abrupt rise of water surface. (2) The sudden and usually turbulent abrupt rise in water surface in an open channel when water flowing at high velocity is suddenly retarded to a slow velocity.

Hydraulic Loading — (Wastewater Treatment) (1) Hydraulic loading refers to the flows (MGD or cu m/day) to a treatment plant

or treatment process. Detention times, surface loadings and weir overflow rates are directly influenced by flows. (2) For a sand filter wastewater treatment unit, the volume of wastewater applied to the surface of the filtering medium per time period. The loading is often expressed in gallons per day per square foot (gpd/ft²), or cubic meters per square meter per day (m³/m²d).

Hydraulic Mining — Mining by washing sand and dirt away with water, leaving the desired mineral.

Hydraulic Permeability — The flow of water through a unit cross-sectional area of soil normal to the direction of flow when the *Hydraulic Gradient* is unity.

Hydraulic Population Equivalent — A flow of 100 gallons per day is the hydraulic or flow equivalent to the contribution or flow from one person. Population equivalent = 100 GPCD or gallons per capita per day.

Hydraulic Profile — A vertical section showing the level to which water will rise in an *Aquifer*.

Hydraulic Radius — (1) Cross-sectional area divided by the wetted perimeter. (2) The cross-sectional area of a stream of water divided by the length of that part of its periphery in contact with its containing conduit; the ratio of area to wetted perimeter. Also referred to as *Hydraulic Mean Depth*.

Hydraulic Ram — A device which uses the energy of falling water to force a small portion of the water to a height greater than the source. A water pump in which the downward flow of naturally running water is intermittently halted by a valve so that the flow is forced upward through an open pipe into a reservoir.

Hydraulic Transient — (1) Interim stage when a flow changes from one steady-state condition to another steady-state condition because of a sudden acceleration or deceleration of flow. (2) A wave or pressure change propagated through a canal or pipeline during unsteady flow.

Hydraulics — (1) Water in motion. (2) The study of liquids, particularly water, under all conditions of rest and motion. (3) The branch of physics having to do with the mechanical properties of water and other liquids in motion and with the application of these properties in engineering.

Hydric — (Ecology) (1) Describing organisms that live or thrive in a wet or moist environment. (2) Characterized by, relating to, or requiring an abundance of moisture; referring to a habitat characterized by wet or moist conditions rather than *Mesic* (moderate moisture conditions) or *Xeric* (dry conditions).

Hydric Soil — (1) A soil that, in its undrained condition, is saturated, flooded, or ponded long enough during the growing season to develop *Anaerobic* conditions that favor the growth and regeneration of hydrophytic vegetation (*Hydrophytes*). Hydric soils consist of soils that are frequently flooded and/or waterlogged and are typically associated with wetlands. Lakes and river bottoms also have hydric substrates (since they don't support free-standing vegetation). Technically, any soil that is inundated (i.e., covered by water) for two weeks or more during the growing season in most years is considered a hydric soil. Most hydric soils have distinct properties that help separate them from better drained soils of uplands (i.e., drylands). These properties include: (a) thick organic deposits in the upper part of the soil (anaerobic conditions slow down oxidation of organic matter); (b) grayish subsoils (due to lack of iron oxides); (c) mottled soils (grayish subsoil with orangish, yellowish, or reddish mottles, reflecting a fluctuating water table, but also prolonged saturation); (d) a rotten egg odor coming from the upper part of the soil (hydrogen sulfide from organic matter decomposition); (e) black sands (due to heavy organic coatings of much of the sand grains); and (f) blotchy sandy soils (with organic streaking or variable coloring of the sand due to differences in the amount of organic coatings of sand grains). (2) A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop *Anaerobic* conditions in the upper part. The concept of hydric soils includes soils developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation. Soils that are sufficiently wet because of artificial measures are included in the concept of hydric soils. Also, soils in which the hydrology has been artificially modified are hydric if the soil, in an unaltered state, was hydric. Some series, designated as hydric, have phases that are not hydric depending on water table, flooding, and ponding characteristics. Nearly all hydric soils exhibit characteristic morphologies (alterations) that result from repeated periods of saturation and/or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes a depletion of oxygen. This *Anaerobiosis* promotes biogeochemical processes such as the accumulation of organic matter and the reduction, translocation, and/or accumulation of iron and other reducible elements. These processes result in characteristic morphologies which persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils. A combination of the hydric soil, hydrophytic vegetation, and hydrology criteria defines wetlands as described in the National Food Security Act Manual (*Natural Resources Conservation Service*) and the Wetlands Delineation Manual (*U.S. Army Corps of Engineers*). Therefore an area that meets the hydric soil criteria must also meet the hydrophytic vegetation and wetland hydrology criteria in order for it to be classified as a Jurisdictional Wetland. Field Indicators of Hydric Soils in the United States has been developed by soil scientists of the Natural Resources Conservation Service (NRCS) in cooperation with the *U.S. Fish and Wildlife Service (USFWS)*, the U.S. Army Corps of Engineers (COE), the *U.S. Environmental Protection Agency (EPA)*, various regional, state, and local agencies, universities, and the private sector.

Hydric Soils Field Indicators — Indicators of *Hydric Soils* are formed predominantly by the accumulation or loss of iron (Fe), manganese (Mn), sulfur, or carbon compounds. The presence of hydrogen sulfide gas is a strong indicator of a hydric soil, but is typically found in only the wettest sites containing sulfur or sulfur compounds. While indicators related to Fe/Mn depletions or concentrations are the most common hydric soil indicator, they cannot form in soils whose parent materials contain low amounts of Fe/Mn. For such soils, features related to accumulations of organic carbon are most frequently used. Some of these carbon accumulation features such as Indicators A1 (Histosols), A2 (Histic Epipedon), and A3 (Black Histic) are often used to identify hydric soils. However, as they are maximum expressions of *Anaerobiosis*, they are rarely used for delineation purposes.

Hydrilla — An exotic (nonnative) aquatic weed, hydrilla (*Hydrilla verticillata*) has come to represent a serious threat to lakes, reservoirs, streams and canals in the United States. A native of Asia, Africa, and Australia, hydrilla is part of a group of rooted aquatic plants well adapted to growth under water. Hydrilla was first introduced to the U.S. in Florida during the 1950s, probably

for use in aquariums. Hydrilla is capable of prodigious growth, expanding from a few acres to several thousand acres in two to three years. Due to its ability to photosynthesize under very low light conditions, hydrilla becomes easily established in turbid waters and at greater depths than other aquatic plants. Most populations in the U.S. comprise *dioecious* female plants; reproduction is asexual, including fragmentation and the formation of hardy, long-lived *propagules*, called turions or tubers, which form deep in the sediment and remain viable for as long as ten years. Once hydrilla has invaded a site, the diversity of other rooted, submersed aquatic plants plummets, resulting in monospecific stands of hydrilla and loss of biodiversity. At its peak population, hydrilla has reduced water flows in canal systems by up to 80 percent and in small, standing-water impoundments, such as lakes and ponds, hydrilla can often completely cover the water surface within two to three years.

Hydro — The prefix denoting water or hydrogen.

Hydrobiology — The biological study of bodies of water, especially studies by *Limnology* *Hydrobiologist*.

Hydrocarbons — Chemical compounds that consist entirely of carbon and hydrogen, such as petroleum, natural gas, and coal.

Hydrocolloid — A substance that forms a gel with water.

Hydrocompaction — The settling and hardening of land due to application of large amounts of water for irrigation.

Hydrodynamic Dispersion — (1) Spreading (at the macroscopic level) of the solute front during transport resulting from both mechanical dispersion and molecular diffusion. (2) The process by which groundwater containing a solute is diluted with uncontaminated groundwater as it moves through an aquifer. Also see *Dispersion Coefficient*.

Hydrodynamic Force — The force exerted by moving water. Contrast with *Hydrostatic Force*.

Hydrodynamic Loads — Forces imposed on structures by floodwaters due other impacts of moving water on the upstream side of the structure, drag along its sides, and eddies or negative pressures on its downstream side.

Hydrodynamics — (1) The branch of science that deals with the dynamics of fluids, especially incompressible fluids, in motion. (2) The branch of science that deals with the cause and effect of regional subsurface fluid migration. (3) The branch of hydraulics that relates to flow of liquids through pipes and openings.

Hydroelectric — Having to do with production of electricity by water power from falling water.

Hydroelectric Plant (Conventional) — A hydroelectric power plant which utilizes streamflow only once as the water passes downstream; electric power plant in which the energy of falling water is used to spin a turbine generator to produce electricity..

Hydroelectric Plant (Pumped Storage) — A hydroelectric power plant which generates electric power during peak load periods by using water pumped into a storage reservoir during off-peak periods.

Hydroelectric Power — Power (hydroelectricity) produced using water power as a source of energy. Electrical energy generated by means of a power generator coupled to a turbine through which water passes.

Hydroelectric Power Water Use (Withdrawals) — The use of water in the generation of electricity at plants where the turbine generators are driven by falling water. This constitutes an *Instream Use* of water and is a nonconsumptive use of water. The terms “water use” and “water withdrawals” are equivalent, but not the same as *Consumptive Use* as they do not account for return flows.

Hydroelectricity — Electric energy production by water powered turbine generators.

Hydroexplosion — (Volcanology) Any volcanic explosion caused by a sudden generation of steam as, for example, when water comes in contact with hot lava or rock.

Hydrofoil — (Nautical) (1) A wing-like structure attached to the hull of a boat that raises all or part of the hull out of the water when the boat is moving forward, thus reducing drag. (2) A boat equipped with hydrofoils. In this sense, also referred to as a *Hydroplane*.

Hydrofracturing — Process of increasing the permeability of strata near a well by pumping in water and sand under high pressure. Hydraulic pressure opens cracks, and sand introduced into the cracks keeps them open when the pressure is reduced.

Hydrogen — (Chemical symbol H) An element commonly isolated as a colorless, tasteless, odorless gas, inflammable (burning with a hot, almost nonluminous flame to form water), and lighter than any other known substance. Free hydrogen occurs only very sparingly on the earth, though it is abundant in the atmospheres of the sun and many stars. Hydrogen is combined with *Oxygen* in *Water* (H₂O), of which it constitutes 11.188 per cent by weight. It is also a constituent of most organic compounds, of acids and bases. Ordinary hydrogen gas is diatomic (its molecules consisting of two atoms, H₂), but dissociates into free atoms at high temperatures. The hydrogen atom is the simplest of all atoms, the ordinary isotope (H¹) consisting of a single proton and a single valence electron. It is accompanied by a minute amount of a heavier isotope called Deuterium (H² or D) which is used in *Heavy Water* (D₂O). Atomic number 1; atomic weight 1.00797; melting point -259.14EC (-434.45EF); boiling point -252.8EC (-423.04EF); density at 0EC (32EF) 0.08987 gram per liter.

Hydrogen Bond — A type of chemical bond caused by electromagnetic forces, occurring when the positive pole of one molecule (e.g., water) is attracted to and forms a bond with the negative pole of another molecule (e.g., another water molecule).

Hydrogen Ion Concentration — The concentration of hydrogen ions in an aqueous solution is a function of the degree of dissociation of the liquid, and determines its character as an acid or a base. This variable is conveniently expressed in terms of the value pH, which represents the logarithm of the reciprocal of the gram equivalents per liter of the hydrogen ion. More simply expressed, the pH value is a number between 0 and 14 which represents the degree of alkalinity or acidity of the water. A pH value of 7 indicates, in the case of pure water at 25°Celsius, exact neutrality, since it contains the same concentration of H⁺ ions as OH⁻ ions, while lower values indicate a preponderance of H⁺ ions which are acidic and higher values indicate a basic character of the water with an excess of OH⁻ ions which are alkaline.

Hydrogen Sulfide (Gas) — Chemical symbol H₂S, hydrogen sulfide is produced naturally by the *Anaerobic Decomposition* of any type of organic or inorganic matter that contains sulfur, e.g., rotting eggs, wallboard decomposition in landfills, the formation of natural gas from decomposing plant life, sulfate decomposition in sewers, etc. However produced, hydrogen sulfide presents severe health and corrosion hazards as well as being an odor nuisance. Few gases are as potent as hydrogen sulfide to the human

olfactory senses. The human nose can detect the rotten egg odor at a level of only 0.4 parts per billion (ppb); few other compounds can be detected at such low levels of concentration.

Hydrogenation — Form of reduction in which hydrogen, in gaseous form, is caused to react with a substance in the presence of a catalyst at high pressure.

Hydrogeologic — Those factors that deal with subsurface waters and related geologic aspects of surface waters.

Hydrogeologic Conditions — Conditions stemming from the interaction of groundwater and the surrounding soil and rock.

Hydrogeologic Cycle — The natural process of recycling water from the atmosphere down to (and through) the earth and back to the atmosphere again.

Hydrogeologic Parameters — Numerical parameters that describe the hydrogeologic characteristics of an aquifer such as *Porosity*, *Permeability*, and *Transmissivity*.

Hydrogeologic Unit — Any soil or rock unit or zone that because of its hydraulic properties has a distinct influence on the storage or movement of groundwater.

Hydrogeological Cycle — The natural process recycling water from the atmosphere down to (and through) the earth and back to the atmosphere again. Also see *Hydrologic Cycle*.

Hydrogeology — (1) The geology of *Groundwater*, with particular emphasis on the chemistry and movement of water; the scientific study of subsurface water, especially the study of the flow characteristics of underground water. (2) The part of geology concerned with the functions of water in modifying the earth, especially by erosion and deposition; geology of groundwater, with particular emphasis on the chemistry and movement of water.

Hydrogeologist — A person who studies and works with groundwater.

Hydrogeomorphic — An assessment procedure, typically for *Wetlands*, including tidal fringe wetlands, estuaries, marshes, bogs, and other similar bodies of water serving specific wetland-type functions (i.e., filtration, tidal surge attenuation, wildlife habitat, etc.) that is based on three fundamental factors that influence how the particular body of water functions: (a) position in the landscape (i.e., its geomorphic setting); (b) water source (i.e., hydrology and hydrologic characteristics); and (c) the flow and fluctuation of the water once in the wetland (i.e., hydrodynamics). Also see *Hydrogeomorphic Approach* and *Hydrogeomorphic (HGM) Classification System*.

Hydrogeomorphic Approach (Wetlands) [Corps] — A wetland classification system supported by the *U.S. Army Corps of Engineers (Corps)* being implemented through the National Action Plan that will form the basis of strategies carried out by the Corps and other Federal agencies. These strategies will be followed in the development of the Hydrogeomorphic Approach for assessing wetland functions (HGM Approach). The National Action Plan was developed by a National Interagency Implementation Team comprised of the Corps of Engineers, *U.S. Environmental Protection Agency (EPA)*, *Natural Resource Conservation Service (NRCS)*, *Federal Highways Administration (FHA)*, and the *U.S. Fish and Wildlife Service (USFWS)*. The HGM Approach is being developed primarily for use in the context of the *Clean Water Act (CWA) Section 404* regulatory program where time and resources are often limited. It is expected that the HGM Approach to wetland assessment will increase the accuracy of wetland function assessments, allow for replicability to other similar wetland areas, and reduce the amount of time required to conduct a wetland function assessment. The HGM Approach is based on three fundamental factors that influence how wetlands function: position in the landscape (geomorphic setting), water source (hydrology), and the flow and fluctuation of the water once in the wetland (hydrodynamics). The approach first classifies wetlands based on their differences in functioning, second it defines functions that each class of wetlands performs, and third it uses reference to establish the range of functioning of the wetland. Regional assessment models are developed based on the functional profile that describes the physical, biological, and chemical characteristics of a regional wetland subclass. Also see *Hydrogeomorphic (HGM) Classification System (Wetlands) [Corps]*.

Hydrogeomorphic (HGM) Classification System (Wetlands) [Corps] — A wetlands classification system that has been developed to address a wide range of geological, climatic, and physiographic conditions which have typically made wetland assessments more difficult. The HGM classification system identifies groups of wetlands that function similarly, thereby reducing the level of variability. Under the HGM classification system, wetlands are grouped using three fundamental criteria that influence wetland functions: geomorphic setting, water source, and hydrodynamics. These are described as follows:

- [1] Geomorphic setting refers to the landscape position and geologic evolution of a wetland;
- [2] Water source refers to the origin of the water just prior to entering the wetland; primary water sources include precipitation, surface flow, and groundwater; and
- [3] Hydrodynamics refers to the energy and direction of water flow within a wetland.

According to the HGM classification system, seven broad classes of wetlands are recognized:

- Riverine (floodplain, riparian, and channel environments);
- Tidal Fringe (occupying coastal margins);
- Lacustrine Fringe (lake edge);
- Depressional (prairie potholes, playa lakes);
- Slope (seepage areas);
- Mineral Flats (wet pine savannas); and
- Organic Flats (peatbogs).

Each wetland class has been identified based on significant differences in variables that affect their functional attributes, in addition to any regional differences and influences. Tidal wetlands, for example, constitute an important wetland category and by definition belong to the HGM Class “Tidal Fringe” in that they occur along the shoreline of coastal ecosystems and are subject to the ebb and flow of tides. Intertidal marshes, forested swamps along tidally influenced river reaches, and mangrove swamps

are also included in this class. Also see *Hydrogeomorphic Approach (Wetlands) [Corps]*.

Hydrogeomorphic Unit — A land form characterized by a specific origin, geomorphic setting, water source, and hydrodynamic attributes and characteristics.

Hydroglider — A hydroplane.

Hydrognosy — The history and description of the waters of the earth.

Hydrograph — (1) A graphic representation or plot of changes in the flow of water or in the elevation of water level plotted against time. A graph of the rate of runoff plotted against time for a point on a channel. (2) A graph to show the level (*Stage*), flow (*Discharge*), or velocity of water in a river at all seasons of the year. (3) The trace of stage (height) or discharge of a stream over time, sometimes restricted to the short period during storm flow. (4) A graph showing stage, flow, velocity, or other hydraulic properties of water with respect to time for a particular point on a stream. Hydrographs of wells show the changes in water levels during the period of observation.

Hydrographic — (1) Relating to the physical features of water areas or the study of such areas. (2) Of or pertaining to *Hydrography* as in the description and study of seas, lakes, rivers, and other waters.

Hydrographic Apex — The highest point on an *Alluvial Fan* where flow is last confined.

Hydrographic Area — In its most general sense, may refer to an defined geographic area, sub-area, sub-basin, basin, region or watershed encompassing the drainage area or catchment area of a stream, its tributaries, or a portion thereof. Typically defined as a study area for analysis or planning purposes in which the land or undersea contours results in surface water flows or measures of elevation draining to a single point. At its smallest extent, a hydrographic area may encompass a single valley containing a single stream system, or a portion of a valley or stream system with distinctive drainage characteristics. At its greatest extent, a hydrographic area may encompass the entire drainage area of a major river system, e.g., the Mississippi River hydrographic area, including all tributary rivers, streams and other sources of surface water flow. Conventionally, a number of hydrographic sub-areas comprise a hydrographic area whereas a number of hydrographic areas comprise a hydrographic basin or region.

Hydrographic Area [Nevada] — The 232 subdivisions (256 *Hydrographic Areas* and *Hydrographic Sub-Areas*) of the 14 Nevada *Hydrographic Regions* as defined by the State Engineer's Office, Department of Conservation and Natural Resources, Division of Water Resources. Primarily these are sub-drainage systems within the 14 major drainage basins. Hydrographic areas (valleys) may be further subdivided into hydrographic sub-areas based on unique hydrologic characteristics (e.g., differences in surface flows) within a given valley or area.

Hydrographic Region [Nevada] — Nevada has been divided into 14 hydrographic regions or basins, which are now used by the Nevada Division of Water Resources, Department of Conservation and Natural Resources, and the U.S. Geological Survey (USGS) to compile information pertaining to water resources and water use. These regions are also further subdivided into 232 *Hydrographic Areas* (256 *Hydrographic Areas* and *Sub-Areas*, combined) for more detailed study. See *Basins [Nevada]*, for a complete listing and description of Nevada's 14 Hydrographic Regions.

Hydrographic Study Area — An area of hydrological and climatological similarity so subdivided for study purposes.

Hydrographic Survey — (1) An instrumental survey to measure and determine characteristics of streams and other bodies of water within an area, including such things as location, areal extent, and depth of water in lakes or the ocean, the width, depth, and course of streams; position and elevation of high water marks; location and depth of wells. (2) (Oceanography) A survey of the physical characteristics of a body of water, especially its currents, chemical and physical properties, and bottom relief. (3) (Navigation) A survey of this type made specifically to determine depth, bottom topography, location of aids and impediments to navigation, and other properties in order to produce charts and maps for use in navigation, flood control, and water supply and storage.

Hydrographic Table — (Oceanography) A tabulation that relates seawater density to *Salinity*, temperature, and pressure.

Hydrography — (1) The study, description, and mapping of oceans, lakes, and rivers, especially with reference to their navigational and commercial uses. Specifically includes the measurement of flow and investigation of the behavior of streams, especially with reference to the control or utilization of their waters, as well as the surveying, sounding, and charting of water bodies. (2) That branch of surveying which embraces the determination of the contour of the bottom of a harbor or other sheet of water, the dept of soundings, the position of channels and shoals, with the construction of charts exhibiting these particulars.

Hydrokinetics — The branch of physics having to do with fluids in motion.

Hydrologic — Of or pertaining to hydrology, that is the science dealing with water, its properties, phenomena, and distribution over the earth's surface.

Hydrologic Alteration — Modification of the amount or movement of water through an ecosystem. This includes drainage of wetlands, dams, levees, aquifer mining, reservoirs, and channelization of rivers and streams.

Hydrologic Balance — An accounting of all water inflows to, water outflows from, and changes in water storage within a hydrologic unit over a specified period of time.

Hydrologic Basin — The complete drainage area upstream from a given point on a stream.

Hydrologic Benchmark — A hydrologic unit, such as a basin or a ground-water body, that because of its expected freedom from the effects of man, has been designated as a benchmark. Data from such basins may provide a standard with which data from less independent basins can be compared so that changes wrought by man's interference can be distinguished from changes caused by variations in the natural regimen.

Hydrologic Benchmark Station — A station that provides hydrologic data for a basin in which the hydrologic regimen will likely be governed solely by natural conditions. Data collected at a benchmark station may be used to separate effects of natural from human-induced changes in other basins that have been developed and in which the physiography, climate, and geology are similar to those in the undeveloped benchmark basin.

Hydrologic Budget — (1) An accounting of the inflow, outflow, and storage in a hydrologic unit, such as a drainage basin, aquifer,

soil zone, lake, reservoir, or irrigation project. (2) An evaluation of the balance of water in an area, such as a drainage basin or *Aquifer*, taking into account the inflow, outflow, and storage, and the relationship among evaporation, precipitation, and runoff. Also referred to as *Hydrologic Accounting*, *Hydrologic Balance*, or *Hydrologic Inventory*.

Hydrologic Condition — The runoff potential of a particular cropping practice. A crop under good hydrologic condition will have a higher infiltration rate and lower runoff potential than one under poor conditions.

Hydrologic Cycle — (1) The process in which water evaporated from rivers, lakes, and oceans rises and condenses into clouds, and then falls back to Earth as rain, hail, sleet or snow. (2) Movement or exchange of water between the atmosphere and the earth. The cycling of water from the atmosphere, onto and through the landscape and eventually back into the atmosphere. (3) The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transportation. (4) Biogeochemical cycle that collects, purifies, and distributes the earth's fixed supply of water from the environment, to living organisms, and back to the environment. Also referred to as the *Water Cycle* and *Hydrogeologic Cycle*.

Hydrologic Equation — The water inventory equation: $\text{Inflow} = [\text{Outflow} + \Delta \text{Storage}]$, which balances the *Hydrologic Budget* and expresses the basic principle that during a given time interval the total inflow to an area must equal the total outflow plus the net change in storage.

Hydrologic Equilibrium — An expression of the law of mass conservation for water budgets in which inflows equal outflows, corrected for changes in storage.

Hydrologic Model — Mathematical formulations that simulate hydrologic phenomenon considered as processes or as systems.

Hydrologic Processes — Physical operation or series of operations that result in movement of water within a hydrologic system.

Hydrologic Region — A study area, consisting of one or more planning subareas, used to analyze water use and hydrologic conditions. Typically such areas are based on *Watersheds*.

Hydrologic Regions [California] — For water planning and conservation purposes, the California *Department of Water Resources (DWR)* and the *State Water Resources Control Board (SWRCB)* have divided the state into 10 *Hydrologic Regions*, also referred to as a *Hydrologic Study Area (HSA)*, and are based on the *Watershed* or *Water Basin* concept. These California HSAs include:

- [1] **North Coast Region** – Comprises all of the California area tributary to the ocean from the mouth of Tomales Bay north to the Oregon border and east along the border to a point near Goose Lake. The region includes all or large portions of Modoc, Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Lake and Sonoma counties. It also includes small areas of Shasta, Tehama, Glenn, Colusa, and Marin counties. Most of the region is comprised of rugged mountains; the dominant topographic features are the Klamath Mountains and the Coast Range. Most land area in the region is forest or range land. Irrigated acreage is concentrated in narrow river valleys such as the Russian River Valley in Sonoma County, and on the high plateau of the Klamath River Basin. Principal cities in the region include Crescent City, Yreka, Eureka, Fort Bragg, Ukiah, Santa Rosa, and Rohnert Park. The region consists of 19,590 square miles (12 percent of the state's total area), 606,000 persons (1.9 percent of the state's total population – all populations as of 1995), and approximately 323,000 irrigated crop acres. Average annual precipitation is 53 inches (range: 10 to over 100 inches), totaling 55.9 million acre-feet (29.1 percent of total state precipitation), and average annual runoff is 28.9 million acre-feet (40.8 percent of total state runoff).
- [2] **San Francisco Bay Region** – Extends from Pescadero Creek in southern San Mateo County to the mouth of Tomales Bay in the north and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville. The region includes all of San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. Geographic features include the Marin and San Francisco peninsulas, San Francisco, Suisun, and San Pablo bays, and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Range. The region is highly urbanized and includes the San Francisco, Oakland, and San Jose metropolitan areas. Agricultural lands are located mostly in the north. The region consists of 4,400 square miles (3 percent of the state's total area), 5,780,000 persons (18 percent of the state's total population), and approximately 65,000 irrigated crop acres. Average annual precipitation is 31 inches (range: 13 to almost 48 inches), totaling 5.5 million acre-feet (2.9 percent of total state precipitation), and average annual runoff is 1.2 million acre-feet (1.7 percent of total state runoff).
- [3] **Central Coast Region** – Encompasses the area adjacent to the Pacific Ocean including Santa Cruz County in the north through Santa Barbara County in the south to the Diablo and Temblor mountain ranges on the east. The region includes the southern tip of San Mateo county, part of Santa Clara County, most of San Benito County, all of Santa Cruz, Monterey, San Luis Obispo and Santa Barbara counties, and the northwestern tip of Ventura County. The major topographic features include Monterey and Morro bays, the Pajaro, Salinas, Carmel, Santa Maria, Santa Ynez and Cuyama valleys, the Coast Range, and the coastal plain of Santa Barbara County. The principal population centers in the region are Santa Cruz, Hollister, Salinas, Monterey, Paso Robles, San Luis Obispo, Santa Maria, Goleta, and Santa Barbara. The region consists of 11,280 square miles (7 percent of the state's total area), 1,347,000 persons (4 percent of the state's total population), and approximately 572,000 irrigated crop acres. Average annual precipitation is 20 inches (range: 10 to 50 inches), totaling 12.3 million acre-feet (6.4 percent of total state precipitation), and average annual runoff is 2.5 million acre-feet (3.5 percent of total state runoff).
- [4] **South Coast Region** – Extends eastward from the Pacific Ocean, the region is bounded by the Santa Barbara–Ventura county line and the San Gabriel and San Bernardino mountains on the north, the Mexican border on the south, and a combination of the San Jacinto Mountains and low-elevation mountain ranges in central San Diego County on the east. The region is California's most urbanized hydrologic region. Topographically, the region is comprised of a series of broad coastal plains, gently sloping interior valleys, and mountain ranges of moderate

elevations. The largest of these ranges are the San Gabriel, San Bernardino, San Jacinto, Santa Rosa, and Lauguna Mountains. The largest cities in the region are Los Angeles, San Diego, Long Beach, Santa Ana, and Anaheim. The region consists of 10,950 square miles (7 percent of the state's total area), 17,299,000 persons (54 percent of the state's total population), and contains approximately 313,000 irrigated crop acres. Average annual precipitation is 18.5 inches (range: 10 to 45 inches), totaling 10.8 million acre-feet (5.6 percent of total state precipitation), and average annual runoff is 1.2 million acre-feet (1.7 percent of total state runoff).

- [5] **Sacramento River Region** – Contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Sacramento–San Joaquin Delta north to the Oregon border to the crest of the Sierra Nevada and Cascade Ranges which form the eastern border to the crest of the Coast Range forming the western side. The region includes all or large portions of Modoc, Siskiyou, Lassen, Shasta, Tehama, Glenn, Plumas, Butte, Colusa, Sutter, Yuba, Sierra, Nevada, Placer, Sacramento, El Dorado, Yolo, Solano, Lake, and Napa counties. The region is defined by two distinct features – the foothill and mountain areas of the Sierra Nevada, Cascade, and Coast ranges, and the Sacramento Valley floor. Major population areas include Sacramento and the surrounding areas. The region consists of 26,960 square miles (17 percent of the state's total area), 2,372,000 persons (7 percent of the state's total population), and contains 2,139,000 irrigated crop acres. Average annual precipitation is 36 inches (range: 10 to 80 inches), totaling 52.4 million acre-feet (27.3 percent of total state precipitation), and average annual runoff is 22.4 million acre-feet (31.6 percent of total state runoff).
- [6] **San Joaquin River Region** – Located in the heart of California bordered on the east by the crest of the Sierra Nevada and on the west by the coastal mountains of the Diablo Range, extending from the Delta and the Cosumnes River drainage south to include all of the San Joaquin River watershed. The region contains all or portions of Alameda, Alpine, Amador, Calaveras, Contra Costa, El Dorado, Fresno, Madera, Mariposa, Merced, Sacramento, San Benito, San Joaquin, Stanislaus, and Tuolumne counties. The principal population centers include the cities of Lodi, Stockton, Tracy, Modesto, Turlock, Merced, and Madera. The region consists of 15,950 square miles (10 percent of the state's total area), 1,592,000 persons (5 percent of the state's total population), and contains 2,005,000 irrigated crop acres. Average annual precipitation is 13 inches (range: 9 to 35 inches), totaling 21.8 million acre-feet (11.3 percent of total state precipitation), and average annual runoff is 7.9 million acre-feet (11.2 percent of total state runoff).
- [7] **Tulare Lake Region** – Includes the southern half of the San Joaquin Valley from the southern limit of the San Joaquin River watershed to the crest of the Tehachapi Mountains, stretching from the Sierra Nevada Crest in the east to the Coast Range in the west. Most of the region's population is located on the east side of the San Joaquin Valley in several rapidly growing cities, the largest of which are Fresno, Bakersfield, and Visalia. The region consists of 16,520 square miles (10 percent of the state's total area), 1,554,000 persons (5 percent of the state's total population), and contains 3,127,000 irrigated crop acres. Average annual precipitation is 14 inches, totaling 13.9 million acre-feet (7.2 percent of total state precipitation), and average annual runoff is 3.3 million acre-feet (4.7 percent of total state runoff).
- [8] **North Lahontan Region** – Comprises the eastern drainages of the Cascade Range and the eastern Sierra Nevada, north of the Mono Lake drainage. The region includes parts of Sierra, Nevada, Placer, El Dorado, Alpine, and Mono counties. The region encompasses a Lassen portion in the north and an Alpine portion in the south. Susanville is the largest population center in the northern portion of the region, and the Town of Truckee and South Lake Tahoe are the largest population areas in the southern portion of the region. The region consists of 3,890 square miles (less than 3 percent of the state's total area), 84,000 persons (less than 0.3 percent of the state's total population), and contains 161,000 irrigated crop acres. Average annual precipitation of 32 inches (range: 4 to 70 inches), totaling 6.0 million acre-feet (3.1 percent of total state precipitation), and average annual runoff is 1.9 million acre-feet (2.7 percent of total state runoff).
- [9] **South Lahontan Region** – Encompasses the area from the mountain divide north of Mono Lake to the divide south of the Mojave River, which runs through the Mojave Desert, bordered on the east by the Nevada state line and on the west by the crest of the Sierra Nevada. The region includes all of Inyo County and parts of Mono, San Bernardino, Kern, and Los Angeles counties. Prominent geographic features of the region are Owens Valley and Death Valley. The region also contains the highest and lowest points in the lower United States – Mount Whitney and Death Valley, respectively. The region consists of 29,020 square miles (18 percent of the state's total area), 713,000 persons (2 percent of the state's total population), and contains 61,000 irrigated crop acres. Average annual precipitation is 8 inches (range: 4 to 10 inches, with extremes of 1.9 inches in Death Valley and over 120 inches at Mammoth Lakes), totaling 9.3 million acre-feet (4.8 percent of total state precipitation), and average annual runoff is 1.3 million acre-feet (1.8 percent of total state runoff).
- [10] **Colorado River Region** – Encompasses the southeastern corner of California with the region's northern boundary, a drainage divide, beginning along the southern edge of the Mojave River watershed in the Victor Valley area of San Bernardino County and extending northeast across the Mojave Desert to the Nevada state line. The southern boundary is the Mexican border while a drainage divide forms the jagged western boundary through the San Bernardino, San Jacinto, and Santa Rosa mountains and the Peninsular ranges and the Nevada state line and the Colorado River form the region's eastern boundary. Much of the region's topography consists of flat plains punctuated by hills and mountain ranges. The San Andreas fault traverses portions of the Coachella and Imperial valleys. A prominent topographic feature is the Salton Trough in the south-central part of the region. The region, consists of 19,730 square miles (12 percent of the state's total area), 533,000 persons (less than 2 percent of the

state's total population), and contains 749,000 irrigated crop acres. Average annual precipitation is 5.5 inches (range: 3 to 36 inches), totaling 4.3 million acre-feet (2.2 percent of total state precipitation), and average annual runoff is 0.2 million acre-feet (0.3 percent of total state runoff).

Hydrologic Soil Groups — The classification of soils by their reference to the intake rate of infiltration of water, which is influenced by texture, organic matter content, stability of the soil aggregates, and soil horizon development.

Hydrologic Study Approach — The study of a project's water distribution based upon a hydrological balance, where inflow (diversion into project) is balanced with outflow (precautionary drawdowns, crop consumptive use, deep seepage, surface return flows, and undefined "losses").

Hydrologic Study Area (HSA) — See *Hydrologic Regions [California]*.

Hydrologic System — A complex structure of related parts – physical, conceptual, or both – forming an orderly working body of hydrologic units and interacting hydrologic processes.

Hydrologic Unit — (1) A geographic area representing part or all of a surface drainage basin or distinct hydrologic feature. (2) (USGS) A geographic area representing part or all of a surface drainage basin or distinct hydrologic feature as defined by the former Office of Water Data Coordination and delineated on the State Hydrologic Unit Maps by the U.S. Geological Survey. Each hydrologic unit is identified by an 8-digit number. (3) A classification of soils concerning water infiltration characteristics used in hydrologic analyses. See *Hydrologic Unit Maps*.

Hydrologic Unit Maps [USGS] — A set of maps developed by the U.S. Geological Survey (USGS) that present information on drainage, culture, hydrography, and hydrologic boundaries and codes of (1) the 21 major water-resources regions and the 222 subregions designated by the U.S. Water Resources Council, (2) the 352 accounting units of the U.S. Geological Survey's National Water Data Network, and (3) the 2,149 cataloging units of the U.S. Geological Survey's "Catalog of Information on Water Data." The hydrologic unit map series was initiated in the fall of 1972 by the U.S. Geological Survey's Office of Water Data Coordination, in cooperation with the U.S. Water Resources Council and supported by the U.S. Geological Survey's Resources and Land Information program. These maps and associated codes provide a standardized base for use by water-resources organizations in locating, storing, retrieving, and exchanging hydrologic data, in indexing and inventorying hydrologic data and information, in cataloging water-data acquisition activities, and in a variety of other applications. Because the maps have undergone extensive review by all principal federal, regional and state water-resource agencies, they are widely accepted for use in planning and describing water-use and related land-use activities, and in geographically organizing hydrologic data. The maps depict a hydrologic system that divides the United States into 21 major regions. These regions are further subdivided into 222 subregions, 352 accounting units, and finally, into 2,149 cataloging units. These four levels of subdivisions, used for the collection and organization of hydrologic data, are referred to as *Hydrologic Units*. Also see *Water Resources Regions [United States]*.

Hydrologic Units (Classification Codes) [USGS] — A means by which the United States has been divided and subdivided into successively smaller *Hydrologic Units* which have been classified into four levels consisting of 21 major water resources regions, 222 subregions, 352 accounting units and 2,149 cataloging units. The first level of this U.S. Geological Survey (USGS) classification system divides the U.S. into 21 major geographic areas, or regions. These geographic areas (hydrologic areas based on surface topography) contain either the drainage area of a major river or the combined drainage areas of a series of rivers. Eighteen of the regions occupy the land area of the conterminous U.S.; Alaska is region 19, the Hawaiian Islands constitute region 20, and Puerto Rico and other outlying Caribbean areas are region 21. (The Pacific Trust Territories are a potential region 22.) The second level of classification divides the 21 regions into 222 subregions. A subregion includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage area. The third level of classification subdivides many of the subregions into accounting units. These 352 hydrologic accounting units nest within, or are equivalent to, the subregions. The accounting units are used by the USGS for designing and managing the National Water Data Network. The fourth level of classification is the cataloging unit, the smallest element in the hierarchy of hydrologic units. A cataloging unit is a geographic area representing part or all of a surface drainage basin, a combination of drainage basins, or a distinct hydrologic feature. These units subdivide the subregions and accounting units into smaller areas (2,149 in the U.S.) that are used by the USGS for cataloging and indexing water-data acquisition activities in the "Catalog of Information on Water Data." An eight-digit code uniquely identifies each of the four levels of classification within four two-digit fields. The first two digits identify the water resources region; the first four digits identify the subregions; the first six digits identify the accounting unit; and the addition of two more digits identify the cataloging unit. See *Water Resources Regions [United States]* for a complete listing of the 21 major water resources regions.

Hydrological Drought — The onset of this form of drought is signified by the occurrence and/or persistence of *Meteorological Drought*, causing shortage of surface water in streams, lakes, reservoirs and/or groundwater supplies. Also see *Agricultural Drought*.

Hydrologist — A person who studies or is trained in the field of *Hydrology*. A scientist or technician who specializes in *Hydrology*.

Hydrology — (1) The science of waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, including living beings. (2) The study of the movement and storage of water in the natural and disturbed environment. (3) The condition of the aquatic environment at some specified time and place. Most frequently, the term is used in reference to water on the surface of the land, in the soil and underlying rocks, and in the atmosphere. (4) The study of the water of the earth, its properties and distribution and its transformations, combinations and movements, especially from the time of its precipitation on land until its discharge into the sea or return to the atmosphere. Analysis within this field is directed particularly to the occurrence of water on the earth, the description of the earth with respect to water, the physical effects of water on the earth, and the relation of water to life on the earth.

Hydrolysis — (1) A chemical reaction in which a compound is converted into another compound by taking up water. (2) The

splitting (lysis) of a compound by a reaction with water. Examples are the reaction of salts with water to produce solutions which are not neutral, and the reaction of an ester with water.

Hydromancy — Divination by the observation of water, as in observing the ebb and flow of tides, by crystal vision, or mechanical contrivance. A form of divination, especially common in Egypt, in which a medium, regularly a young boy, reported on images visible to him in water, supposedly manifestations of the Gods.

Hydromania — A mania or morbid craving for water.

Hydrome — Water-conducting tissue.

Hydromechanics — The branch of physics having to do with the laws governing the motion and equilibrium of fluids.

Hydrometamorphism — (Geology) The alteration of rock caused by the infiltration of water and the subsequent addition, removal, or exchange of materials in the absence of high temperature or pressure. Also referred to as *Hydrometasomatism*.

Hydrometeor — (1) Any type of condensation or frost formed from atmospheric water vapor, such as rain, snow, fog, dew, etc. (2) Any substance produced by the condensation or sublimation of water vapor in the air. This includes rain, drizzle, hail, snow, sleet (ice pellets), etc. Contrasts with *Lithometeor*.

Hydrometeorology — The science of the application of meteorology to hydrologic problems; the branch of meteorology that deals with the occurrence, motion, and changes of the state of atmospheric water. The combination of snowpack measurements and climatic forecasts to predict runoff.

Hydrometer — An instrument used to determine specific gravity, especially a sealed, graduated tube, weighted at one end, that sinks in a fluid to a depth used as a measure of the fluid's specific density.

Hydrometric Network — Network of stations at which measurement of hydrological parameters is performed.

Hydronic — Of, relating to, or being a system of heating or cooling that involves transfer of heat by a circulating fluid (as water or vapor) in a closed system of pipes.

Hydrotherapy — Internal and external use of water as a therapeutic treatment for all forms of disease. Compare to *Hydrotherapy*.

Hydroperiod — The seasonal and cyclical pattern of water in a *Wetland*.

Hydrophile (Hydrophilic) — (1) Water loving. The property of attracting or combining with water. (2) Having or denoting a strong affinity for water; said of *Colloids* which swell in water and which are not easily coagulated. The opposite of *Hydrophobic*.

Hydrophilous — (Botany) (1) Growing or thriving in water. (2) Pollinated by water, as the flowers of ribbon grass and hornwort.

Hydrophobe (Hydrophobic) — Lacking strong affinity for water; said of *Colloids* which are easily coagulated. The opposite of *Hydrophilic*.

Hydrophobia — (1) An abnormal fear of water. (2) Rabies.

Hydrophone — An electrical instrument for detecting or monitoring sound transmitted through water.

Hydrophyte — (1) A perennial vascular aquatic plant having its overwintering buds under water. (2) A plant growing in water or in soil too waterlogged for most plants to survive. (3) A plant adapted to grow in water. (4) Any plant growing only in water or very wet earth, requiring large quantities of water for growth. See *Hydrophytic Vegetation*. Also see *Mesophyte*, *Phreatophyte*, *Xerophyte*.

Hydrophytic Vegetation — (1) Plants that grow in water or in saturated soils that are periodically deficient in oxygen as a result of high water content. Examples include cattails, bulrushes, sedges, and rushes. (2) Plants adapted to life in water or in waterlogged substrates are called *Hydrophytes*. They tend to be more water-tolerant than "water loving." Prolonged saturation creates oxygen-deficient substrates in just a few days. Since all plants require oxygen for survival and growth, only plants with special adaptations or colonization strategies can live and reproduce under these circumstances. Out of all the vascular plants that grow in the United States, only about one third can tolerate the wetness conditions associated with most wetlands.

Hydroplane — (Nautical) (1) A motorboat designed so that the prow and much of the hull lift out of the water and skim the surface at high speeds. Also referred to as a *Hydrofoil*. (2) Seaplane. (3) A horizontal rudder on a submarine.

Hydropneumatic — A water system, usually small, in which a water pump is automatically controlled by the pressure in a compressed air tank.

Hydroponics — Cultivation of plants in nutrient solution rather than in soil.

Hydropower — Power (e.g., electrical energy) produced by falling water; the utilization of the energy available in falling water for the generation of electricity.

Hydropsis — (Oceanography) A sub-field of *Oceanography* that is concerned with continuous observation, collection, and reporting of oceanographic data, particularly data relevant to commercial fishing.

Hydroscope — An optical device used for viewing objects far below the surface of water.

Hydroseeding — Dissemination of seed under pressure, in a water medium. Mulch, lime, and fertilizer can be incorporated in the spraying mixture.

Hydrosere — (Ecology) A community that is created by plants migrating to open water, decomposing, and forming moss or peat deposits.

Hydrosol — A disperse system (colloid) in which water is the disperse medium.

Hydrosphere — (1) The water on or surrounding the surface of the globe. (2) The portion of the Earth that is water, including liquid water, ice, and water vapor on the surface, underground, or in the atmosphere. (3) Strictly, all waters of the Earth, as distinguished from water in the rocks (*Lithosphere*), water within living things (*Biosphere*), and water in the air (*Atmosphere*). (4) The region that includes all the Earth's liquid water, frozen water, floating ice, frozen upper layer of soil, and the small amounts of water vapor in the earth's atmosphere. (5) More generally, the aqueous envelope of the Earth, including the ocean, all lakes, streams, and underground waters, as well as the water vapor in the atmosphere. And more precisely, together, the waters of the *Hydrosphere*, *Atmosphere*, *Lithosphere*, and *Biosphere*, constitutes the Earth's *Ecosphere*.

Hydrostatic Approximation — (Meteorology) An assumption that the *Atmosphere* is in a state of *Hydrostatic Equilibrium*.

Hydrostatic Equilibrium — See *Hydrostatic Pressure*.

Hydrostatic Force — The force exerted by water at rest, including lateral pressure on walls and uplift (buoyancy) on floors. Contrast with *Hydrodynamic Force*.

Hydrostatic Head — A measure of pressure at a given point in a liquid in terms of the vertical height of a column of the same liquid which would produce the same pressure.

Hydrostatic Law — See *Hydrostatic Pressure*.

Hydrostatic Loads — (1) Forces imposed on a flooded structure due to the weight of the water. (2) (Floods) Those loads or pressures resulting from the static mass of water at any point of floodwater contact with a structure. They are equal in all directions and always act perpendicular to the surface on which they are applied. Hydrostatic loads can act vertically on structural members such as floors, decks, and roofs, and can act laterally on upright structural members such as walls, piers, and foundations.

Hydrostatic Pressure — (1) The pressure in a fluid in equilibrium which is due solely to the weight of fluid above. (2) The pressure at a specific elevation exerted by a body of water at rest. The pressure of, or corresponding to, the weight of a column of water at rest. (3) In the case of groundwater, the pressure at a specific elevation due to the weight of water at higher levels in the same zone of saturation. (4) Also referred to as the *Hydrostatic Law*, the force exerted by a body of fluid at rest. It increases directly with the density and the depth of the fluid and is expressed in pounds per square inch or kilopascals. The hydrostatic pressure of fresh water is 0.433 pounds per square inch per foot of depth (9.792 kilopascals per meter). (5) In drilling, the term refers to the pressure exerted by the drilling fluid in the wellbore. In a water drive field, the term refers to the pressure that may furnish the primary energy for production. The pressure at a given depth in a static liquid is a result the weight of the liquid acting on a unit area at that depth plus any pressure acting on the surface of the liquid, P_{air} . Therefore, the pressure at depth is given by:

$$P = P_{\text{air}} + (\rho) \times (g) \times (h)$$

The pressure due to the liquid alone (i.e. the hydrostatic pressure) at a given depth depends only upon the density of the liquid ρ , gravity, g , and the distance below the surface of the liquid, h . Therefore,

$$P = \rho \times g \times h$$

An object satisfying the hydrostatic law is said to be in *Hydrostatic Equilibrium*. Said to be of water that has no tendency to rise or fall, i.e., hydrostatic pressure (forces) below and above are equal.

Hydrostatic System — (Wastewater Treatment) In a hydrostatic sludge removal system, the surface of the water in the clarifier is higher than the surface of the water in the sludge well or hopper. This difference in pressure head forces sludge from the bottom of the clarifier to flow through pipes to the sludge well or hopper.

Hydrostatics — The branch of physics that deals with fluids at rest and under pressure.

Hydrotherapy — External use of water in the medical treatment of diseases. Compare to *Hydropathy*.

Hydrothermal — (1) Of or relating to hot or heated water, to its actions, or to products related to its actions. (2) Having to do with hot water, especially having to do with the action of hot water in producing minerals and springs or in dissolving, shifting, and otherwise changing the distribution of minerals in the Earth's crust. (3) (Geology) Of or relating to hot magmatic emanations rich in water. Of or relating to the rocks, ore deposits, and springs produced by such emanations.

Hydrothermal Alteration — (Geology) The alteration of rocks by the interaction of *Hydrothermal Water* with preformed solid phases.

Hydrothermal Deposit — (Geology) A mineral deposit formed when hot, aqueous solutions fill fractures or other open spaces in rocks or along faults. The minerals crystallize as the solutions cool. Also see *Hypothermal Ore Deposit*.

Hydrothermal Reservoir — One of three geothermal reservoir systems. It consists of naturally circulating hot water or steam ("wet steam") or that which contains mostly vapor ("dry steam"). The latter type of reservoir is the most desirable type according to present technology. Also see *Geothermal Energy*.

Hydrothermal Solution — A hot, watery solution that usually emanates from a magma in the late stages of cooling. Frequently contains and deposits in economically workable concentrations minor elements that, because of incommensurate ionic radii or electronic charges, have not been able to fit into the atomic structures of the common minerals of igneous rocks (rocks formed by volcanic activity).

Hydrothermal Synthesis — (Geology) The synthesis of minerals in the presence of heated water.

Hydrothermal Vent — (Oceanography) A fissure in the sea bottom through which hot aqueous solutions rise from the magma beneath the crust.

Hydrotransport (Hydro-Transport) — (1) Mixing a crushed material, such as coal, gravel or sand, with water to facilitate its transport under pressure, through a pipes. (2) (Tar Sands) Mixing the crushed black sands containing bitumen — a heavy, molasses-like oil — with hot water in a "cyclo-feeder" to facilitate its transportation via pipeline to plants where the bitumen is separated from the water and then "cracked" in cokers into various hydrocarbon by-products, i.e., naphtha, kerosene, and heavy fuel oil.

Hydrotropism — Growth or movement in a sessile (fixed, root-bound) organism toward or away from water, as of the roots of a plant.

Hydrous — Containing water, especially water of crystallization or hydration.

Hyetal — (Meteorology) (1) Of or relating to rain or other precipitation. (2) Of or relating to rain or rainy regions.

Hyetal Equator — (Meteorology) A line or zone that circles the earth north of the geographical equator and lies between two belts

- characterizing the annual time distribution for rainfall in the lower latitudes of each hemisphere; a type of meteorological equator.
- Hyetograph** — (Meteorology) (1) An instrument that collects and measures precipitation, recording its temporal and areal distribution. (2) A chart showing the distribution of rainfall over a particular period of time or a particular geographic area.
- Hyetography** — (Meteorology) The branch of meteorology having to do with the geographical distribution and annual variation of rainfall. Also see *Hyetograph*.
- Hyetology** — (Meteorology) A branch of *Meteorology* that involves the study of all forms of precipitation.
- Hygrokinematics** — (Meteorology) A branch of *Meteorology* that involves the study of movement of water substance in the atmosphere.
- Hygrology** — (Meteorology) A branch of *Meteorology* that involves the study of the humidity in the atmosphere.
- Hygrometer** — Any of several instruments used to measure atmospheric humidity.
- Hygrometry** — (Meteorology) The scientific study and calculation of the relative humidity of the atmosphere.
- Hygrophyte** — Plants extremely sensitive to dry air, growing only in habitats where relative humidity is always high. Also see *Hydrophyte*.
- Hygroscope** — An instrument showing changes in humidity.
- Hygroscopic** — (1) Absorbing or attracting moisture from the air. (2) Describing a chemical substance with an affinity for water, one that will absorb moisture, usually from the air. Silica gel and zinc chloride are hygroscopic materials that are used as drying agents.
- Hygroscopic Capacity** — See *Hygroscopic Coefficient*.
- Hygroscopic Coefficient** — (1) The level of tension at which water is considered to be “bound” to the soil particles, i.e., 31 atmospheres. (2) The percentage of water that will be absorbed by a completely dry mass of soil and be held in equilibrium if the soil comes in contact with a saturated atmosphere. Also referred to as *Hygroscopic Capacity*.
- Hygroscopic Moisture** — See *Hygroscopic Water*.
- Hygroscopic Nuclei** — A piece of dust or other particle around which water condenses in the atmosphere. These tiny droplets then collide and coalesce, with numerous other nuclei, contributing to the formation of a raindrop.
- Hygroscopic Water** — (1) Water which is absorbed from the air. (2) Moisture that adheres to soil particles and does not evaporate at ordinary temperatures. Also referred to as *Hygroscopic Moisture*.
- Hygrothermograph** — (Meteorology) (1) An instrument that records both temperature and humidity on one graph. (2) An instrument which combines the features of the *Hair Hygograph* and the *Thermograph*, recording both relative humidity and temperature on one chart.
- Hyperaccumulators** — Plants used in various *Phytoremediation* processes that can absorb high levels of contaminants with their roots and concentrate them either there or in shoots and leaves. Researchers have found hyperaccumulator species by collecting plants in areas where soil contains greater than usual amounts of metals or other potentially toxic compounds because of geological factors or pollution. Among the plants that have been collected and used in field trials are species from the genus *Thlaspi*, or *Alpine ennycress*, which accumulate zinc, cadmium, or lead, and the *Alyssum* species, which accumulate nickel. Both genera belong to the mustard family *Brassicaceae*. Plants from other families also have been shown to remove cobalt, copper, chromium, manganese, or selenium from contaminated soils. Also see *Pytoextraction*.
- Hypereutrophic (Water)** — Pertaining to a lake or other body of water characterized by excessive nutrient concentrations such as nitrogen and phosphorous and resulting high productivity. Such waters are often shallow, with algal blooms and periods of oxygen deficiency. Slightly or moderately eutrophic water can be healthful and support a complex web of plant and animal life. However, such waters are generally undesirable for drinking water and other needs. Degrees of *Eutrophication* typically range from *Oligotrophic* water (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hypereutrophic* water (minimum transparency, maximum chlorophyll-a, maximum phosphorus). Also see *Carlson's Trophic State Index (TSI)* and *(Mean) Trophic State Index (TSI)*.
- Hyperhaline** — Term used to characterize waters with salinity greater than 40‰ (parts per thousand), due to ocean-derived salts.
- Hypersaline** — Term used to characterize waters with salinity greater than 40‰ (parts per thousand), due to land-derived salts.
- Hypochlorination** — The application of *Hypochlorite* compounds to water for the purpose of disinfection.
- Hypochlorinators** — Chlorine pumps, chemical feed pumps or devices used to dispense chlorine solutions made from *Hypochlorites* such as bleach (sodium hypochlorite) or calcium hypochlorite into the water being treated.
- Hypochlorite** — Chemical compounds containing available chlorine; used for disinfection. They are available as liquids (bleach) or as solids (powder, granules and pellets). Salts of *Hypochlorous Acid*.
- Hypochlorous Acid** — An unstable strongly oxidizing but weak acid, HClO, obtained in solution along with hydrochloric acid by reaction of chlorine with water and used especially in the form of salts as an oxidizing agent, bleaching agent, disinfectant, and chlorinating agent.
- Hypolimnetic Discharge** — The process of removing nutrient-rich, oxygen-deficient water from the bottom of a lake or reservoir to improve water quality conditions.
- Hypolimnetic** — Refers to the cold bottom water zone below the *Thermocline* in a lake.
- Hypolimnion** — (1) The lowermost, non-circulating layer of cold water in a thermally *Stratified Lake* or reservoir that lies below the *Thermocline*, remains perpetually cold and is usually deficient of oxygen. (2) The relatively colder lowermost layer of water in a lake. Specifically, the denser, stagnant or oxygen-deficient lower layer of a *Thermally* stratified lake, lying below the thermocline and unaffected by sunlight. (3) The lowest layer in a thermally stratified lake or reservoir. This layer consists of colder, more dense water, has a constant temperature and no mixing occurs. (4) Bottom waters of a thermally *Stratified Lake*. The hypolimnion of a *Eutrophic Lake* is usually low or lacking in oxygen. Also see *Thermal Stratification*.
- Hypopycnal Inflow** — (1) A flowing in of water that is less dense than the water into which it flows. (2) (Oceanography) Typically,

an inflow of fresh water into the denser saline water of the ocean.

Hyporheic Zone — Zone of substrate in a stream bottom extending 1 to 2 meters (3.3 to 6.6 feet) below the surface of the stream bed. In gaining and in losing streams, water and dissolved chemicals can move repeatedly over short distances between the stream and the shallow subsurface below the streambed. The hyporheic zone is comprised of the resulting subsurface environments, which contain variable proportions of water from groundwater and surface water. These zones can be active sites for aquatic life, for example, the spawning success of fish may be greater where flow from the stream brings oxygen into contact with eggs that were deposited within the coarse bottom sediment or where stream temperatures are modulated by groundwater flows.

Hypothermal — (1) Moderately warm; tepid. (2) Pertaining or tending to reduction of temperature.

Hypothermal Ore Deposit — A mineral deposit that originated from hot, ascending solutions derived from a magma.

Hypothermia — (1) Subnormal temperature of the body. (2) A serious physical condition caused by a lowering of the core body temperature as from exposure to cold water for an excessive period of time. Symptoms include lack of coordination, thickness of speech, irrationality, blueness of skin, dilation of pupils, decrease in heart and respiratory rate, extreme weakness, and uncontrolled shivering. Victims often become unconscious and sometimes die. In terms of first aid for hypothermia, quickly remove wet clothes and administer hot drinks, etc.

Hypothesis — (Statistics) A statement made about the condition or behavior of a variable or event which lends itself to rigorous testing for validity. An informed theory that best describes a set of available data. The assumption is stated in such a way that subsequent experimentation or observations can test the validity of the theory.

Hypothesis Testing — (Statistics) The condition whereby the *Null Hypothesis*, which argues against the validity of the model's structure (*Specification*) is tested using various statistical criteria, e.g., *Coefficient of Determination*, or R^2 , *t-Statistic*, *F-Statistic*, etc., against the *Alternative Hypothesis* that there exists a significant relationship or correlation between the dependent variable, or variable to be explained, and the independent, or explanatory variable(s). In hypothesis testing, a rule for acceptance and rejection must be chosen, e.g., 5 percent level of significance, that is, there exists a 5 percent chance that in rejecting the null hypothesis, which states that the disturbances in the dependent variable are purely random, we will be wrong. Inversely, there is a 95 percent chance that by rejecting the null hypothesis and accepting the alternative hypothesis, we will be right.

Hypoxia — (1) A condition in which natural waters have a low concentration of *Dissolved Oxygen* (about 2 milligrams per liter as compared with a normal level of 8 to 10 milligrams per liter). Most game and commercial species of fish avoid waters that are *Hypoxic*. (2) A condition in which the dissolved oxygen in a body or parcel of water is low enough to have biological effects. Fish and other creatures can survive short periods of hypoxia, but long periods of reduced oxygen can dramatically alter the ecosystem. The *U.S. Environmental Protection Agency (EPA)* defines hypoxic water as water with oxygen concentrations of 2 milligrams per liter or less.

Hypoxia/Hypoxic Waters — Waters with dissolved oxygen concentrations of less than 2 parts per million (ppm), the level generally accepted as the minimum required for most marine life to survive and reproduce.

Hypoxic — Waters that have a very low oxygen level.

Hypsography — (1) The science or art of describing elevations of land surfaces with reference to a datum, usually *Mean Sea Level (MSL)*. (2) That part of topography dealing with relief or elevation of terrain.

Hypsometer — An instrument using the atmospheric pressure as measured by the change in the boiling point of water to determine land elevations.

I

Ice — (1) A solid form of water. (2) Water in the solid state, produced by the freezing of liquid water, by the condensation of water vapor directly into crystals, or by the compaction and re-crystallization of fallen snow. (3) Water frozen, or reduced to the solid state by cold. Ice is a transparent, nearly colorless, crystalline, and brittle substance. Water in freezing expands about one eleventh of its volume, the specific gravity of ice being 0.9166, that of water at 4EC (39.2EF) being 1.0. Pure water freezes at 0EC (32EF), and ice melts at the same temperature.

Ice Accretion — The process by which a layer of ice builds up on the exposed surfaces of solid objects.

Ice Age — (1) A cold period marked by episodes of extensive glaciation alternating with episodes of relative warmth. 2. (*Ice Age*) The most recent glacial period, which occurred during the *Pleistocene Epoch*. (3) (Geology) A popular name for the Pleistocene epoch, so called because of its widespread glacial ice. Also referred to as the *Great Ice Age*.

Ice Apron — (1) A thin mass of relatively immobile snow and ice that is attached to the rock cliff at the back of a cirque. (2) Ice that flows from an ice sheet over the edge of a plateau. (3) (Civil Engineering) A wedge-shaped structure that protects bridge piers from floating ice.

Ice Avalanche — The sudden fall of broken glacier ice down a steep slope. Also referred to as an *Icefall*.

Ice Band — A layer of ice within firn or snow.

Ice Barrier — (1) A term for various formations or obstructions of ice, such as ice front or *Ice Shelf*. (2) The outer margin of the antarctic ice sheet.

Ice Boundary — The boundary between fast and pack ice, or between areas having different concentrations of *Pack Ice*.

Ice Cake — A piece of floating sea ice less than 10 meters in diameter.

Ice Cap (or Icecap) — A perennial dome-shaped or platelike mantle of ice and snow, having an area of less than 50,000 square kilometers, that covers the summit of a mountain or a flat landmass and spreads out radially under its own weight.

Ice Cave — Any cave having a low enough temperature for ice to form and remain more or less throughout the year. Also referred to as *Ice Grotto*.

Ice Crust — A continuous layer of ice formed on the surface of snow by the freezing of meltwater or rainwater. See *Ice Rind*.

Ice Crystal — Any one of a variety of crystalline shapes assumed by ice, such as hexagonal columns, hexagonal platelets, or ice needles.

Ice-Crystal Cloud — (Meteorology) A cloud that consists entirely of ice crystals, having a diffuse and fibrous appearance.

Ice-Crystal Haze — (Meteorology) A very fine ice fog that is composed entirely of ice crystals and may extend to altitudes as high as 20,000 feet.

Ice Dam — Blocks of floating ice that obstruct a river and may cause flooding during spring and early summer.

Ice Day — (Meteorology) For a given area, a 24-hour period in which the air temperature does not rise above 32EF, and ice on the surface of water does not thaw.

Ice Desert — (Meteorology) A polar area that is permanently covered by snow and ice and is essentially devoid of vegetation.

Ice Feathers — A term for *Hoarfrost* forming on the windward side of objects and on aircraft flying from cold to warm layers of air.

Ice Field (or Icefield) — (1) A large sheet of land ice covering a mountainous region and consisting of many interconnected glaciers. (2) An extensive region of unbroken pack ice. (3) (Oceanography) A flat sheet of sea ice more than 8 kilometers in diameter; the largest areal subdivision of sea ice.

Ice Flow — See *Glacier Flow*.

Ice Flower — (1) A formation of leafy ice crystals on the surface of ice or snow that resembles a flower. Also referred to as a *Frost Flower*. (2) A formation of ice crystals on the surface of a quiet body of water.

Ice-Free (or Ice Free) — (1) Describing a water surface that is essentially free of ice. Marked by a lack of obstructive ice. (2) (Navigation) Describing a harbor or other body of water that is free of ice that would impede navigation throughout the year. Free of ice and open to travel or navigation, as an ice-free channel in a river.

Ice Fringe — (1) A belt of sea ice that extends a short distance from the shore. (2) A narrow, seaward-sloping mass of coastal ice that extends less than one kilometer inland from the sea. See *Ice Ribbon*.

Ice Front — The high, steep, floating vertical cliff that forms the seaward edge of a *Glacier*.

Ice Gland — A roughly cylindrical column of ice or *Iced Firn* within a *Firn Field*.

Ice Grotto — See *Ice Cave*.

Ice Gruel — A slushy mass of floating ice formed by the irregular freezing together of *Frazil* on the surface of the ocean.

Ice Island — (Oceanography) A large, generally level, homogeneous floating sheet of ice in Arctic regions, up to 300 square miles in area and often persisting for several decades.

Ice Island Iceberg — (Oceanography) A conical or dome-shaped iceberg, easily mistaken for an ice-covered island.

Ice Jam — (1) An accumulation of blocks of river ice that obstruct part of the channel. (2) An accumulation of broken river ice caught in a narrow channel which develops during a mid-winter or spring thaw and frequently producing local floods. (3)

- (Oceanography) Large fragments of lake or sea ice that have thawed loose in spring and been blown against the shore.
- Ice Layer** — (1) A layer of solid ice or iced firn within a mass of snow or firn. (2) A more or less horizontal layer of ground ice.
- Ice-Minus** — Of or relating to a strain of genetically altered bacteria that are applied to crop plants to inhibit the formation of frost.
- Ice Needle** — (1) A thin ice crystal floating high in the atmosphere in certain conditions of clear, cold weather. (2) An ice crystal that is characterized by an elongated hexagonal shape. Also referred to as an *Ice Spicule*.
- Ice Nucleus** — Any particle that serves as a nucleus in the formation of ice crystals in the atmosphere.
- Ice-Out** — The thawing of ice on the surface of a body of water, such as a lake.
- Ice Pack** — (1) A large area of floating pieces of ice driven together more or less closely. (2) A folded sac filled with crushed ice and applied to sore or swollen parts of the body to reduce pain and inflammation. Also referred to as an *Ice Bag*.
- Ice Pellets** — See *Sleet*.
- Ice Point** — The temperature, equal to 1.0EC (33.8EF), at which pure water and ice are in equilibrium in a mixture at 1 atmosphere of pressure.
- Ice Pole** — (Oceanography) The center of the Arctic pack ice, currently near 84 degrees north latitude and 160 degrees west longitude; by surface travel, the least accessible point of the pack.
- Ice Push** — (1) The lateral force exerted by expanding, shoreward-moving ice on a lake or bay. Also referred to as *Ice Thrust*. (2) The ridge of material formed by such a force. Also referred to as *Lake Rampart*.
- Ice Ribbon** — A thin, white, curly deposit of ice crystals formed on plant surfaces by the freezing of moisture exuded from dead stems.
- Ice Rind** — A brittle, thin, hard crust of sea ice formed on a quiet surface of water having a low salinity, either by direct freezing or from *Grease Ice*.
- Ice Run** — (1) The rapid breakup of river ice in spring or early summer. (2) The rush of water that follows such a breakup.
- Ice Sheet** — (1) A broad, thick sheet of ice covering an extensive area for a long period of time. (2) A broad, thick sheet of glacier ice that covers an extensive land area for a long period of time. Also referred to as *Mantle Ice*. (3) A very large *Ice Cap*, also called continental glacier, as that of the antarctic continent.
- Ice Shelf** — (1) An *Ice Sheet* projecting into coastal waters so that the end floats. (2) (Oceanography) A continuous and more or less permanent sheet of fast ice, generally level and sometimes extending hundreds of kilometers from the shore, fed by glaciers and by annual accumulation of snow; although attached to land, an ice shelf's edge is chiefly supported by the water on which it floats.
- Ice Spicule** — See *Ice Needle*.
- Ice Storm** — (1) A storm in which snow or rain freezes on contact, forming a coat of ice on the surfaces it touches. (2) A storm characterized by a fall of freezing precipitation and formation of *Glaze*.
- Ice Stream** — A stream of ice flowing down a valley, or a high-velocity current of ice flowing within an *Ice Sheet* or *Ice Cap*.
- Ice Tongue** — Any long, narrow extension of a glacier on land or afloat.
- Ice Wall** — A cliff of ice forming the seaward edge of a glacier that is not afloat.
- Ice Water** — Chilled or iced water, especially served as a beverage.
- Iceberg** — A massive piece of ice that breaks off and floats away from a *Glacier*. Icebergs occur as huge blocks, or in peaked forms of great variety and beauty. About one ninth of the bulk of an iceberg projects above sea level.
- Iceblink** — (1) A white or yellow streak in the sky near the horizon, caused by the reflection of light from an area of ice. Also call *Blink*. (2) A coastal ice cliff.
- Icebound** — Locked in or covered over by ice.
- Iccap (or Ice Cap)** — An extensive dome-shaped or plate-like perennial cover of ice and snow that spreads out from a center and covers a large area, especially land. A very large ice cap is an *Ice Sheet*, or continental *Glacier*, as that of the antarctic continent.
- Iced Firn** — A mixture of ice and *Firn*, or firn that has been saturated with meltwater and later re-frozen.
- Icefall (or Ice Fall)** — (1) A chaotic breaking up of ice in a glacier. Also referred to as *Ice Cascade*. (2) A mass of glacial ice that overhangs a precipice. (3) The part of a glacier resembling a frozen waterfall that flows down a steep slope. (4) An avalanche of ice. See *Ice Avalanche*.
- Icefield** — See *Ice Field*.
- Icefog** — A fog of ice particles. Also referred to as *Pogonip*.
- Icefoot** — A belt or ledge of ice that forms along the shoreline in Arctic regions.
- Icequake** — The concussion accompanying the breakup of large ice masses.
- Icescape** — A wide view or vista of a region of ice and snow.
- Icewedge** — A form of clear ice in perennially frozen *Regolith* in the continuous zone of permafrost. Size ranges from 1 millimeter wide "dikelets" to wedges more than 10 meters wide and 10 meters deep.
- Ichthyology** — The study of fishes.
- Ichthyosaurus (Ichthyosaur) [Nevada]** — The chief genus of *Ichthyosauria*, also known by a prior name, *Proteosaurus*. An ancient, extinct marine reptile whose name means "fish-lizard" and who ruled the world's oceans during the Mesozoic era some 200 million years ago. Fossil remains of the Ichthyosaur have been found on every continent except Africa. Possessing a fish-like body, porpoise-like snout, short neck, dorsal and caudal fins with limbs flattened into paddles, the Ichthyosaur ruled the seas for some 135 million years as the pre-eminent marine predator. The Ichthyosaur attained a maximum length of approximately 60–70 feet. The *Ichthyosaurus shonisaurus popularis* was the name given to a species discovered in Nevada in 1928. Some 40 of these reptiles became stranded in mud flats from a receding equatorial sea which once covered the state. The longest specimen found at this site, located at an elevation of 7,000 feet in the Shoshone Mountain Range near the town of Berlin in northwestern Nye County, Nevada, was 55 feet long and represented the only complete fossilized skeleton of the species ever found in the

United States. In 1977 the Nevada State Legislature named the *Ichthyosaurus Shonisaurus popularis* as Nevada's official state fossil.

Iceicle — (1) A tapering spike of ice formed by the freezing of dripping or falling water. (2) A long, slender, downward-pointing, tapering piece of ice formed by the freezing of dripping water.

Iceing — (1) In a *Permafrost* region, an ice mass formed on the surface during the winter by the successive freezing of sheets of water. (2) Any accumulation or coating of ice on a solid object. (3) (Aviation) The freezing of atmospheric moisture on the surface of an aircraft.

Iceings — Sheetlike masses of layered ice formed on the ground surface, or on river or lake ice, by freezing successive flows of water that may seep from the ground, flow from a spring, or emerge from below river or lake ice through fractures. The intensity of iceings in the southern portions of the *Permafrost* zone may change annually, increasing with colder winters and lower snow cover combined with autumnal precipitation. Further north, iceings increase in size but decrease in number when the climate cools, and vice-versa when it warms.

ICR — See *Information Collection Rule*.

Identification — (Statistics) A term used to describe the ability to determine an econometric model's structural parameters, i.e., the coefficients of the exogenous (or independent) variables. An econometric model is said to be exactly identified if the data support a unique set of parameters for the independent variables. A model is said to be *Under-identified* if there is no way of estimating all the structural parameters and *Over-identified* if more than one value is obtainable for some parameters.

Igneous Rock — (Geology) A rock formed by the solidification of molten materials (magma). The rock is extrusive (or volcanic) if it solidifies on the surface and intrusive (or plutonic) if it solidifies beneath the surface.

Illinoian — (Geology) Of or relating to one of the glacial stages of the *Pleistocene* epoch which occurred in North America, which consisted of the *Nebraskan* (first stage), *Kansan* (second stage), *Illinoian* (third stage), and *Wisconsin* (fourth stage).

Illuvial — Describing soil material, usually minerals and colloidal particles, that is removed from the upper soil horizon to a lower soil horizon. Illuvial deposits can form a *Hardpan*.

Illuviation — The deposition in an underlying soil layer of colloids, soluble salts, and mineral particles leached out of an overlying soil layer.

Imbibition — (Chemistry) Absorption of fluid by a solid or colloid that results in swelling.

Imhoff Cone — A clear, cone-shaped container marked with graduations used to measure the volume of settleable solids in a specific volume of water (usually one liter).

Imhoff Tank — An anaerobic sewage treatment tank in which solids are withdrawn from the bottom of the tank.

Immerge — To submerge or disappear in or as if in a liquid.

Immerse — To plunge, drop, or dip into or as if into a liquid, especially so as to cover completely.

Immersible — Capable of being completely immersed in water without suffering damage.

Immiscible — Applied to liquids which are insoluble in each other. The chemical property where two or more liquids or phases do not readily dissolve in one another, such as oil and water.

Immuno-Compromised Persons — People who are more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons, such as those with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk of infections.

Impact — Pollution, contamination, or degradation of the environment caused by wastewater or associated solids that may result from either abandonment of the permitted activity or from an event not caused by an act of nature.

Impact Loads — (Flooding) Loads induced by the collision of solid objects on a structure carried by floodwater. Debris can include trees, lumber, displaced sections of structures, tanks, runaway boats, and chunks of ice. Debris impact loads are difficult to predict accurately, yet reasonable allowances must be made for them in the design of potentially affected structures.

Impact Zone — The spot on a wave where the water is just about to collapse and explode, the spot of greatest danger to and opportunity for a surfer.

Impaired — Water bodies that cannot reasonably be expected to attain or maintain applicable water quality standards, and at least one beneficial use shows some degree of degradation.

Impeller — A rotating set of vanes in a pump designed to pump or lift water.

Imperial Valley [California] — A valley, southeast California, bounded by the Salton Sea on the north, the Chocolate Mountains on the east, and the desert ranges of the Santa Rosa and Vallecito mountains on the west. The valley, crossed by the border between the United States and Mexico, is part of a larger valley that extends south into Mexico; the Mexican section is called Mexicali Valley. Lying below sea level, and formerly an arid desert, the valley is now one of the richest agricultural areas in the world and the largest year-round irrigated agricultural area in North America as a result of irrigation by waters of the Colorado River. The first waters from the Colorado were brought in through the Imperial Canal, opened in 1901. The same source was tapped for the All-American Canal, completed in 1940 as part of the Hoover Dam irrigation system built by the U.S. government. This canal, which is 80 miles (129 kilometers) long and 200 feet (61 meters) wide, is the largest irrigation canal in the U.S. and supplies most of the water for the approximately 404,700 irrigated hectares (about 1 million acres, or 1,562 square miles) of land in the Imperial Valley.

Impermeability — Characteristic of geologic materials that limit their ability to transmit significant quantities of water under the pressure differences normally found in the subsurface environment.

Impermeable — (1) Having a texture that does not permit water to move through it perceptibly under the head differences ordinarily found in subsurface water. (2) Unable to transmit water; not easily penetrated. The property of a material or soil that does not allow, or allows only with great difficulty, the movement or passage of water. Not the same as *Nonporous*.

Impermeable Material — A material that has properties preventing movement of water through it. Nonporous.

Impervious — (1) Not allowing, or allowing only with great difficulty, the movement of water. (2) A term denoting the resistance to penetration by water or plant roots; incapable of being penetrated by water; non-porous.

Impervious Surface — A surface which does not allow water or other liquids to pass through. Examples include asphalt, roof-tops and concrete. Impervious surfaces greatly increase the volume and velocity of runoff and, therefore, the amount of pollution and sediment that enters streams or lakes.

Imperviousness — The portion of a sub-basin, sub-watershed, or watershed, expressed as a percentage, that is covered by surfaces such as roof tops, parking lots, sidewalks, driveways, streets, and highways. Impervious surfaces are important because they will not absorb rainfall and, therefore, cause almost all of the rainfall to appear as surface runoff.

Impervious Soils — Soils that resist penetration by water.

Implied Right — A right that exists without ever being specifically expressed; an understood right.

Import (Water) — Water piped or channeled into an area.

Importation (of Water) — The act or process whereby water is brought into an area or region which would not naturally receive such waters. Typically, it refers to the artificial transport of water through aqueducts, canals, or pipelines from one water basin, drainage area, or *Hydrographic Area* to another, thereby affecting the natural surface and groundwater drainage and flow patterns in both the water exporting and importing areas. In terms of a *Water Banking* or *Water Marketing* concept, such actions to move water from areas of low use to areas of high use place a more realistic monetary value on water as a scarce economic commodity and result in enhanced economic efficiency by putting existing water resources, wherever located, to more productive economic use. However, considerable public concern and controversy surround this practice. These concerns deal primarily with issues relating to altering the natural flows of both surface and groundwaters, adverse environmental and habitat impacts on water exporting areas, the limitations placed on the long-term growth and development of the water exporting region or hydrographic area, the potentially adverse hydrologic effects on groundwater (water table and aquifer) conditions in the exporting area as well as the generally unknown effects on surrounding hydrographic areas and aquifer conditions, and the dependency acquired by the water importing area to continued diversions and water importations. The concept of a public policy limiting an area's development to its natural ability to support population growth only through existing and readily available natural resources, particularly water, is referred to as an *Antediluvian Policy*.

Imported Water — Water that has originated from one hydrologic region and is transferred to another hydrologic region.

Impound — To accumulate and store water as in a reservoir.

Impoundment — (1) Generally, an artificial collection or storage of water, as a reservoir, pit, gugout, or sump. (2) A body of water such as a pond, confined by a dam, dike, floodgate or other barrier. It is used to collect and store water for future use. (3) (Water Quality) Generally an artificial collection and storage area for water or wastewater confined by a dam, dike, floodgate, or other barrier.

Improved Irrigated Acreage — Refers to farm acreage which has been leveled, planed and serviced by improved conveyance and control structures.

In-Line Filtration — The addition of chemical coagulants directly to the filter inlet pipe. The chemicals are mixed by the flowing water. *Flocculation* and *Sedimentation* facilities are eliminated. This pretreatment method is commonly used in pressure filter installations. Also see conventional filtration and direct filtration.

In-Channel Storage — Water storage volume in a canal above the minimum water level required for conveyance.

In-Channel Use — See *Instream Use*.

In Situ — In place, the original location, in the natural environment. An *in situ* environmental measurement is one that is taken in the field, without removal of a sample to the laboratory.

In-Situ Biodegradation — (Environmental) The treatment of soil in place to encourage contaminants to break down. It involves aerating the soil and adding nutrients to promote growth of microorganisms.

In-Situ Stripping — A treatment system that removes or "strips" volatile organic compounds from contaminated ground or surface water by forcing an airstream through the water and causes the compounds to evaporate.

In-Situ Vitrification — (Environmental) A technology used to treat hazardous waste substances in soils. This process electrically melts the waste media at extremely high temperatures, then allows it to cool, creating an extremely stable, insoluble, glass-like solid. The contaminants are destroyed or immobilized and the total volume of material is reduced.

In Vitro — In glass; a laboratory experiment performed in a test tube or other vessel.

In Vitro Studies — Studies of chemical effects conducted in tissues, cells or sub-cellular extracts from an organism (i.e., not in the living organism).

In Vivo — Within a living organism; a laboratory experiment performed in which the substance under study is inserted into a living organism.

In Vivo Studies — Studies of chemical effects conducted in intact living organisms.

Inactive Storage — Lake or reservoir storage not available for release without pumping.

Inch — A fall, as of rain or snow, sufficient to cover the surface to the depth of one inch (2.54 centimeters).

Inch (In., in.) — The depth to which a drainage area would be covered with water if all the runoff for a given time period was uniformly distributed on it.

Inch-Degrees — The product of inches of rainfall times temperature in degrees above freezing (Fahrenheit), used as a measure of the snowmelting capacity of rainfall.

Inchoate Water Right — An unperfected water right. See *Perfected Water Right*.

Incidence — (Statistics) The rate of occurrence of a specific event within a given number of observations over a standard time period.

Incidental Recharge — Groundwater recharge (infiltration) that occurs as a result of human activities unrelated to a recharge project, for example, irrigation and water diversion (unlined canals). Also see *Artificial (or Induced) Recharge*, *Natural Recharge*, and *Perennial Yield*.

Incidental Waste Water Reclamation — Treated waste water returned to fresh-water streams or other water bodies. Additional use made of this treated waste water is only incidental to waste water treatment and disposal.

Incineration — (Water Quality) A treatment technology involving the destruction of waste by controlled burning at high temperatures, e.g., burning sludge to remove the water and reduce the remaining residues to a safe, non-burnable ash that can be disposed of safely on land, in some waters, or in underground locations.

Incised Channel (River) — (1) A river which cuts its channel through the bed of the valley floor, as opposed to one flowing on a floodplain; its channel formed by the process of degradation. (2) A stream that has degraded and cut its bed into the valley bottom. Indicates accelerated and often destructive erosion.

Incised Meander — An entrenched winding of a river, resulting from renewed downcutting in a period of rejuvenation.

Inclined Staff Gage — A gage which is placed on the slope of a stream bank and graduated so that the scale reads directly in a vertical depth.

Inclinometer (Inclometer) — An instrument, usually consisting of a metal or plastic tube, inserted in a drill hole and a sensitized monitor either lowered into the tube or fixed within the tube. This measures at differential points the tube's inclination to the vertical. By integration, the lateral position at different levels of the tube may be found relative to a point, usually the top or bottom of the tube, assumed to be fixed. The system may be used to measure settlement.

Increment — See *Recharge*.

Incrustation — The process by which a crust or coating is formed.

Incubate — To maintain environmental conditions that are optimum for the growth of bacteria. For example, coliforms grow best when held at 37EC (98.6EF).

Incubation Period — The time required between initial contact with an infectious agent and the appearance of the first clinical symptoms of disease.

Independent Utility [USACE] — A test to determine what constitutes a single and complete project in the U.S. Army Corps of Engineers Regulatory Program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases are not built can be considered as separate single and complete projects with independent utility.

Independent Variable — (Statistics) A measurable quantity that, as it takes different values, can be used to predict the value of a *Dependent Variable*. Also referred to as the *Exogenous Variable* or variable to be explained (*Explained Variable*).

Index Model — A hydrologic computer model based on empirical, statistical relationships.

Index of Watershed Indicators (IWI) [EPA] — The Index of Watershed Indicators represents a compilation of information on the "health" of aquatic resources in the United States. The IWI looks at a variety of indicators that point to whether rivers, lakes, streams, wetlands and coastal areas are "well" or "ailing" and whether activities on the surrounding lands that affect our waters are placing them at risk. The earth's waters are one of the world's most valuable resources. They support human, plant, and animal life and the natural environment; promote economic opportunity; and provide beauty and enjoyment for all. The U.S. Environmental Protection Agency (EPA), working with other federal, state, tribal, regional, local, and non-governmental groups, proposed national goals for many aspects of environmental protection. These goals include Clean Waters (i.e., *Clean Water Act*) and Safe Drinking Water (i.e., *Safe Drinking Water Act*). To check the progress in attaining national goals, EPA developed a series of milestones for each goal that set a 10-year target to be reached by the year 2005. In addition, EPA's Office of Water and its partners have adopted five objectives for meeting the Clean Waters and Safe Drinking Water national goals and have developed a series of indicators to measure progress toward those objectives. In addition to EPA data, specific data from states, Native American tribes, the Centers for Disease Control and Prevention, the Center for Marine Conservation, *The Nature Conservancy (TNC)*, the *National Oceanic and Atmospheric Administration (NOAA)*, the U.S. Department of Agriculture (USDA), the *U.S. Fish and Wildlife Service (USFWS)*, and the *U.S. Geological Survey (USGS)* are included. The EPA's watershed indicators have been ordered into five (5) water quality objectives and eighteen (18) water indicators. These objectives and specific indicators include:

[I] **Objective I – Conserve and Enhance Public Health:**

- [1] Population served by community drinking water systems violating health-based requirements measures the nation's population served by drinking water systems with one or more violations of health-based requirements.
- [2] Population served by unfiltered surface water systems at risk from microbiological pollution provides information on the population served by, and number of, systems that have not met the requirements to filter their water to remove microbiological contaminants.
- [3] Population served by drinking water systems exceeding lead action levels measures the total population served by, and number of, systems with lead levels in drinking water exceeding the regulatory threshold.
- [4] Source water protection looks at the number of community drinking water systems using ground water that have programs to protect them from pollution.
- [5] Fish consumption advisories measure the percentage of rivers and lakes with fish that states have determined should not be eaten, or should be eaten in only limited quantities.
- [6] Shellfish growing water classification measures the percentage of estuarine and coastal shellfish growing

waters approved for harvest for human consumption.

[II] Objective II – Conserve and Enhance Aquatic Ecosystems:

- [7] Biological integrity measures the percentage of rivers and estuaries with healthy aquatic communities.
- [8] Species at risk calculates a percentage of aquatic and wetland species currently at risk of extinction.
- [9] Wetland acreage monitors the rate of wetland acreage loss.

[III] Objective III – Support Uses Designated by the States and Tribes in Their Water Quality Standards:

- [10] Designated uses in state and tribal water quality standards assesses (a) the drinking water supply designated use by monitoring waterbodies that can support safe drinking water supply use, as designated by the states and tribes; (b) fish and shellfish consumption designated use by monitoring the waterbodies that can support fish and shellfish consumption, as designated by the states and tribes; (c) recreation designated use which monitors waterbodies that can support safe recreation, as designated by the states and tribes; and (d) aquatic life designated use which includes an assessment of waterbodies that can support healthy aquatic life, as designated by the states and tribes.

[IV] Objective IV – Conserve and Improve Ambient Conditions:

- [11] Ground water pollutants measure the nation's population exposed to nitrate in drinking water. In the future, the EPA intends to have this indicator report the presence of other chemical pollutants in ground water.
- [12] Surface water pollutants monitors the trends of selected pollutants found in surface water.
- [13] Selected coastal surface water pollutants in shellfish measures the concentration levels of selected pollutants in oysters and mussels.
- [14] Estuarine eutrophication conditions monitors the trends in estuarine eutrophication conditions.
- [15] Contaminated sediments measures the percentage of sites with sediment contamination that might pose a risk to humans and aquatic life.

[V] Objective V – Reduce or Prevent Pollutant Loadings and Other Stressors:

- [16] Selected point source loadings measure (a) surface water and (b) ground water trends for selected pollutants discharged from point sources into surface water, and underground injection control wells that are sources of point source loadings into ground water.
- [17] Nonpoint source loadings to surface water assesses the amount of soil eroded from cropland that could run into surface waters. Future reports will include additional nonpoint source surface water pollutants as well as sources of nonpoint source ground water pollution.
- [18] Marine debris assesses trends and sources of debris monitored in the marine environment.

Index of Watershed Indicators [OWOW/EPA] — An electronic database, maintained by the *Office of Wetlands, Oceans, and Watersheds (OWOW)* of the *U.S. Environmental Protection Agency (EPA)*, as part of the *Water Information Network (WIN)*, which compiles information on the health of aquatic resources in over 2,100 watersheds in the 48 contiguous states. Entering a “place” (such as ZIP code, county, tribe, or school) in WIN will generate specific data about a watershed and show the user how they can get involved in watershed issues. As part of its watershed protection program, OWOW is also developing a variety of tools to help states and other partners geographically display and manage their water information. OWOW's Watershed Information Network provides consolidated watershed information and services that can help communities protect and restore water quality.

Index of Wetness — The precipitation for a given year expressed as a ratio to the mean annual precipitation.

Indicator — (Ecology) A quantitative or qualitative variable which can be measured or described and which when observed periodically demonstrates trends. *Ecosystem* indicators track the magnitude of stress, habitat characteristics, exposure to the stressor, or ecological response to exposure.

Indicator (Bacteria) — (Water Quality) Nonpathogenic bacteria whose presence in water indicate the possibility of pathogenic species in the water.

Indicator (Chemical) — A substance that gives a visible change, usually of color, at a desired point in a chemical reaction, generally at a specified end point.

Indicator (Instrument) — A device which indicates the result of a measurement. Most indicators in the water utility field use either a fixed scale and movable indicator (pointer) such as a pressure gage or a movable scale and movable indicator like those used on a circular-flow recording chart. Also called a receiver.

Indicator (Organism) — (Water Quality) An organism, species, or community that shows the presence of certain environmental conditions.

Indicator Gage — A gage that shows by means of an index, pointer, dial, etc., the instantaneous value of such characteristics as depth, pressure, velocity, stage, discharge, or the movements or positions of water-controlling devices.

Indicator Species — (1) (Ecology) A species found only in environments having certain set characteristics, and therefore providing an indication of the nature of the environment in which it is found. (2) (Environmental) Any organism that by its presence or absence, its frequency, or its vigor indicates a particular property of its surrounding environment. A species whose presence is a sign that certain environmental conditions exist. Also see *Management Indicator Species*.

Indicator Tests — (Water Quality) Tests for a specific contaminant, group of contaminants, or constituent which signals the presence of something else. For example, the presence of non-pathogenic coliforms indicate the presence of pathogenic bacteria.

Indicators of Hydrologic Alteration (IHA) [TNC] — A water flow simulation software package developed by *The Nature*

Conservancy (TNC) staff from their Biohydrology Program, in cooperation with Smythe Scientific Software of Boulder, Colorado, that allows hydrologists and ecologists to statistically characterize environmental regimes. It is most commonly used to evaluate streamflow data to help evaluate the health of watersheds and better assess their *Biodiversity* potential and measure freshwater conservation efforts. IHA software helps ecologists and river managers answer questions such as, “Have the natural flows of this stream been altered? By how much? When did changes begin to occur here?” Human societies are increasingly altering the natural flow of rivers and depleting lakes and natural groundwater reserves around the world. For instance, dams, water diversions, and groundwater pumping impact nearly 80 percent of the large rivers in the northern hemisphere. In the United States alone, more than 5,500 large dams have been constructed, along with perhaps more than two million smaller ones. The IHA software uses water data collected by public agencies such as the *U.S. Geological Survey (USGS)* and the *U.S. Forest Service (FS)* and provides a rapid analysis of changes in the water conditions that matter to aquatic species and ecosystems, such as high and low flows and their timing or duration. The program uses daily data (e.g. USGS streamflow records). Such data are available for thousands of locations across the United States. IHA software can be used to contrast two time periods, for example, it can contrast water flow before and after the building of a dam. Alternatively, IHA modeling software can be used to graphically examine long-term trends in environmental regimes. The IHA is currently in use by water resource managers and ecological researchers around the world to examine historical changes in streamflow regimes. It is also widely used as a means for characterizing hydrologic conditions important in ecological research. Aquatic and wetland ecologists are only now beginning to understand the many complex ecological consequences of altering natural water flows and lake levels. For example, changes in the natural timing or reductions in the volume of floods might disorient the migrations of certain fish species. Also, if large floods occur more frequently due to agricultural conversion, or timber harvesting, or urbanization of natural watersheds, they might flush sensitive insects, mussels, and fish downstream. And when too much water is withdrawn from a stream or lake adversely affecting downstream flows, native aquatic creatures may suffer without sufficient adaptation periods. As a simulation tool, IHA helps understand the effects on aquatic *Biodiversity* in rivers, streams, and lakes if some semblance of natural water conditions is not preserved.

Indigenous — Existing, growing, or produced naturally in a region.

Indirect Discharge — The introduction of pollutants from a non-domestic source into a publicly owned waste-treatment system. Indirect dischargers can be commercial or industrial facilities whose wastes enter local sewers.

Indirect Water Uses — Uses of water that are not immediately apparent to the consumer. For example, a person indirectly uses water when driving a car because water was used in the production process of steel and other automotive components.

Indra — (Hinduism) A principal Vedic deity associated with rain and thunder.

Induced Recharge — The designed (as opposed to the natural or incidental) replenishment of groundwater storage from surface water supplies. There exist five (5) common techniques to effect artificial recharge of a groundwater basin:

- [1] **Water Spreading** consists of the basin method, stream-channel method, ditch method, and flooding method, all of which tend to divert surface water supplies to effect underground infiltration;
- [2] **Recharge Pits** are designed to take advantage of permeable soil or rock formations;
- [3] **Recharge Wells** work directly opposite of pumping wells although have limited scope and are better used for deep, confined aquifers;
- [4] **Induced Recharge** results from pumping wells near surface supplies thereby inducing higher discharge towards the well; and
- [5] **Wastewater Disposal** includes the use of secondary treatment wastewater in combination with spreading techniques, recharge pits, and recharge wells to reintroduce the water to deep aquifers thereby both increasing the available groundwater supply and also further improving the quality of the wastewater.

Also referred to as *Artificial Recharge*. Also see *Natural Recharge*, *Incidental Recharge*, and *Perennial Yield*.

Industrial, Self-supplied Water — Water withdrawn from privately developed sources and delivered through water systems established entirely or primarily for commercial and industrial use. Includes water used by mining, manufacturing, military establishments, educational and penal institutions, golf courses, hotels, motels, restaurants, casinos and other small businesses.

Industrial Waste — Unwanted materials from an industrial operation; may be liquid, sludge, or hazardous waste. Also see *Industrial Water Use (Withdrawals)*.

Industrial Wastewater — (Wastewater Treatment) Liquid wastes originating from industrial processing. Because industries have peculiar liquid waste characteristics requiring special consideration, these sources are usually handled and treated separately before being discharged to a wastewater collection system.

Industrial Wastewater Facility — Refers to those facilities that produce, treat or dispose of wastewater not otherwise defined as a domestic wastewater. May include the runoff and leachate from areas that receive pollutants associated with industrial or commercial storage, handling, or processing.

Industrial Water Use (Withdrawals) — (1) Industrial water use includes water used for processing activities, washing, and cooling. Major water-using manufacturing industries include food processing, textile and apparel products, lumber, furniture and wood products, paper production, printing and publishing, chemicals, petroleum, rubber products, stone, clay, glass and concrete products, primary and fabricated metal industries, industrial and commercial equipment and electrical, electronic and measuring equipment and transportation equipment. (2) Water used for industrial purposes such as fabricating, manufacturing, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining. The water can be obtained from a *Public Water Supply System* or may be self-supplied. The terms “water use” and “water withdrawals” are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also see *Self-Supplied Water*. Also see *Commercial Water Use (Withdrawals)*.

Inertia Currents — (Oceanography) (1) Currents occurring after the wind has stopped blowing over a fetch or after the water movement has left the fetch. (2) Circular currents that have a period of half a pendulum day (as recorded by a Foucault pendulum).

Inertial Circle — (Oceanography) A circle described by inertial motion in a body of water, the radius being determined by the formula $R=C/f$, where C represents the particle velocity in a given direction and f the *Coriolis* parameter. Also see *Inertial Theory*.

Inertial Theory — (Oceanography) The theory concerning the effects of inertia and the *Coriolis Force* on ocean currents.

Infauuna — (Ecology) Aquatic animals that live in the substrate of a body of water, especially in a soft sea bottom.

Inference, Bayesian — (Statistics) Bayes' theorem recognizes that a decision maker usually has some expectation (an *a priori* model) of what will occur even before acquiring information, and provides a procedure for using new evidence to produce a revised *a posteriori* estimate of probability. Also see *Statistical Inference* and *Classical Inference*.

Inference, Classical — (Statistics) Statistical inference is based on two basic premises: (1) The sample data constitute the only relevant information; and (2) The construction and assessment of the different procedures for inference are based on long-run behavior under essentially similar circumstances. Also see *Statistical Inference* and *Bayesian Inference*.

Inference, Statistical — (Statistics) The area of statistics that describes the procedures by which we use the observed data (the sample) to draw conclusions about the population from which the data came or about the process by which the data were generated. Our assumptions is that there is an unknown process that generates the data and that this process can be described by a probability distribution, i.e., a likelihood of occurring. Statistical inference can be classified as *Classical Inference* and *Bayesian Inference*.

Infiltrate, also Infiltration — (1) The rate of movement of water from the atmosphere into the soil; that portion of rainfall or surface runoff that moves downward into the subsurface rock and soil; the entry of water from precipitation, irrigation, or runoff into the soil profile. (2) The flow of a fluid into a substance through pores or small openings; to cause a liquid to permeate a substance by passing through its interstices or pores. It connotes flow into a substance in contradistinction to the word *Percolation*, which connotes flow through a porous substance. Also the process whereby water passes through an interface, such as from air to soil or between two soil horizons. (3) The technique of applying large volumes of waste water to land to penetrate the surface and percolate through the underlying soil. (4) (Geology) The flow of a liquid into a solid via pores or small openings; applied specifically to the movement of water into soil or porous rock.

Infiltration — (1) The flow of fluid into a substance through pores or small openings. The word is commonly used to denote the flow of water into soil. (2) The draining or seeping of water into the earth and other entities such as storm water pipes. (3) The gradual flow or movement of water into and through (to percolate or pass through) the pores of the soil. Also see *Percolation*. (4) (Wastewater Treatment) The seepage of groundwater into a sewer system, including service connections. Seepage frequently occurs through defective or cracked pipes, pipe joints and connections, interceptor access risers and covers, or manhole walls.

Infiltration (Alluvial Channel) — The recharge of groundwater from runoff in an *Alluvial Channel*. This alluvial channel recharge is dependent on a number of both hydrologic and geographic factors, some of the most important being: (1) surface area and depth of water in the region; (2) permeability, moisture distribution, and temperature of the subsurface *Alluvium*; (3) physical quality of the water and length of time the water is available at the land surface; (4) chemical quality of the surface and subsurface water; and (5) structural stability of the porous media.

Infiltration and Inflow — (Water Quality) The entrance of groundwater (infiltration) or of surface water (inflow) into sewer pipes. Groundwater can seep through defective pipe joints or cracked pipe sections; roof or basement drains are sources of surface water inflow. Excessive infiltration and inflow can cause sewers to back up or can overload sewage treatment plants, causing a reduction in treatment time or a complete bypass of the treatment process during periods of significant rainfall.

Infiltration Capacity — The maximum rate at which the soil, when in a given condition, can absorb falling rain or melting snow.

Infiltration Capacity Curve — A graph showing the time variation of infiltration capacity. A standard infiltration capacity curve shows the time variation of the infiltration rate which would occur if the supply were continually in excess of infiltration capacity.

Infiltration Capacity, Ultimate — The relatively steady, slow, infiltration capacity which exists after a sufficiently long period of infiltration at capacity rate.

Infiltration Gallery — A subsurface groundwater collection system, typically shallow in depth, constructed with open-jointed or perforated pipes that discharge collected water into a water-tight chamber. From this chamber the water is pumped to treatment facilities and into the distribution system. Infiltration galleries are usually located close to streams or ponds and may be under the direct influence of surface water.

Infiltration Head — (Wastewater Treatment) The distance from a point of infiltration leaking into a collection system to the water table elevation. This is the pressure of the water being forced through the leak in the collection system.

Infiltration Index — The average rate of infiltration, in inches per hour, derived from a time intensity graph of rainfall, so that the volume of rainfall in excess of this rate equals the total direct runoff. Also referred to as a "Φ" (Phi) or "W" index.

Infiltration Rate — (1) Rate of downward movement or flow of water from the surface into the soil. (2) The rate at which infiltration takes place, expressed in depth of water per unit time, usually in inches per hour. (3) The rate, usually expressed in cubic feet per second, or million gallons per day per mile of waterway, at which groundwater enters an infiltration ditch or gallery, drain, sewer, or other underground conduit. (4) Quantity of water (usually measured in inches) that will enter a particular type of soil per unit time (usually one hour).

Infiltration Vein — (Geology) A mineral vein formed in the interstices of the country rock by the action of *Percolating Water*.

Infiltration Water — See *Free Water*.

Infiltrimeter — An instrument which determines the rate and amount of water percolating into the soil by measuring the difference between the amount of water applied and that which runs off. Essentially, the infiltrimeter consists of a sprinkling mechanism

(rain simulator) which provides a rather uniform sprinkling of water to a prescribed area at prescribed rates and size drops (impact), a rain gage (either total or intensity), and a catchment basin or receptacles in which either the rate or total flow of surface runoff is measured. Infiltration or amount absorbed by the soil is usually expressed in inches (of water) per standard interval of time.

Inflatable Dam—(1) Dam structures designed to replace temporary sand levees that wash out during heavy storm flow, the dams hold back high-volume river flows and divert the water into the off-river systems for storage, infiltration, and percolation. (2) A dam constructed of heavy-duty rubber or similar material and inflated with air or water and used for typically small-scale impoundment of flood flows or as flashboards for regulating the overflow of larger dams. Inflatable dams were first developed and used in the 1950's in the Los Angeles, California area. Initially, they were typically inflated with water; however, with improvements in structural materials and design, air is now the preferred inflation medium. Inflatable dams are used in situations requiring small impoundments (say, 100-250 acre-feet) and flexibility of operations. For example, such structures are used to control flood flows, deflating slowly when overflowed and then inflating again once flood debris and peak flows have passed. Inflatable dams are also used in lieu of flashboards on the top of dams providing easier and safer alternatives. Currently (1998) there exist approximately 1,900 of these dams worldwide and 50 are in the United States.

Inflatable Rubber Dams — Designed to replace temporary sand levees that wash out during heavy storm flow, the dams hold back high-volume river flows and divert the water into the off-river system for percolation.

Inflow — (1) The act or process of flowing in or into. (2) Something that flows in or into, as all water that enters a *Hydrologic System*. (3) (Wastewater Treatment) Water discharged into a sewer system and service connections from such sources as, but not limited to, roof leaders, cellars, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, around manhole covers or through holes in the covers, cross connections from storm and combined sewer systems, catch basins, storm waters, surface runoff, street wash waters or drainage. Inflow differs from *Infiltration* in that it is a direct discharge into the sewer rather than a leak in the sewer itself. See *Internal Inflow*.

Inflow Design Flood — The maximum probable flood defined as the largest flood that can be expected to occur on a given stream at a selected point. This flood is used for design to prevent failure of the dam and is determined by the U.S. Department of the Interior, Bureau of Reclamation.

Inflow Zone — An area where a river enters a reservoir.

Influent — Water or other liquid, raw or partially flowing into a reservoir, basin, treatment process or treatment plant.

Influent Seepage — The movement of gravity water in the *Zone of Aeration* from the ground surface toward the water table.

Influent — Refers to the process of flowing in or flowing away. See *Influent Stream*.

Influent Flow — The flow of water into the ground from a body of surface water.

Influent Stream — (1) A surface stream that flows into a lake, or any branch that flows into a larger stream. (2) A stream that has developed bank storage and that loses water to the *Zone of Saturation*. (3) A stream that contributes water to the *Zone of Saturation* and to *Bank Storage*. This term has generally been replaced by the term *Losing Stream*. Also see *Stream*.

Influent Water — Water that flows into sink holes, open cavities, and porous materials and disappears into the ground.

Influx — The place at which a stream flows into the sea or into another stream.

Information — (Data Analysis) The synthesis and manipulation of *Data* through various analytical, tabular, graphical, presentation, or other techniques into a format that readily lends itself to hypothesis testing, planning, and decision making. The fundamental distinction between the data and the information is that the data represents the original observations of an event, characteristic, or phenomenon whereas information represents the transformation of that data, possibly along with the combination of other relevant data and/or other information, into formats that may be used for decision-making purposes.

Information Collection Rule (ICR) — A rule promulgated by the *U.S. Environmental Protection Agency (EPA)* which took effect in January 1997 requiring water districts serving more than 100,000 connections to monitor water supplies for *Cryptosporidium parvum*. The ICR specifies the requirements for monitoring microbial contaminants and *Disinfection By-Products (DBPs)* by large *Public Water Systems (PWSs)*. It also requires large PWSs to conduct either bench- or pilot-scale testing of advanced treatment techniques.

Information Management — (Data Analysis) The manipulation, re-organization, analysis, graphing, charting, and presentation of data for specific management and decision-making purposes. Typically, a fundamental distinction is made between information and data, which constitutes the raw numbers (or descriptions, in the case of qualitative data). Also see *Data Management*.

Infrastructure — (1) An underlying base or foundation, especially for an organization or a system. (2) The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, water and wastewater treatment systems, and public institutions including schools, post offices, and prisons.

Infuse — To steep in liquid (as water) without boiling so as to extract the soluble constituents or principles.

Ingestion — Type of exposure through the mouth.

Ingrown Meander — A stream meander that forms when the rate of downcutting is slow enough to allow for lateral erosion, resulting in an incised meander that expands or grows continually in place.

Inhalation — Type of exposure through the lungs.

Inherited Meander — See *Entrenched Meander*.

Initial Compliance Period — The first full three-year compliance period which begins at least 18 months after promulgation.

Initial Condition — (Data Analysis) The specification of the state of a dynamic system at a specified time; for all subsequent time periods, the equations of motion, state, and divergence are referenced to this initial condition or state.

Initial Detention — The volume of water on the ground, either in depressions or in transit, at the time active runoff begins. It is that part of precipitation that does not appear either as infiltration or runoff at the time active runoff begins. It includes interception by vegetal cover, depression storage, and evaporation during precipitation, but does not include surface detention.

Initial Loss — Rainfall which precedes the beginning of surface runoff. It includes interception, surface wetting, and infiltration, unless otherwise specified.

Initial Storage — That portion of precipitation required to satisfy interception by vegetation, the wetting of the soil surface, and *Depression Storage*.

Initial Water Deficiency — The quantity, usually expressed in depth of water in inches on a unit area, by which the actual water content of a given soil zone (usually the *Root Zone*) is exceeded by the field capacity of that zone at the beginning of the rainy season. Also referred to as *Initial Moisture Deficiency*.

Inject — To introduce, under pressure, a liquid or plastic material into cracks or pores in a rock formation.

Injection — Generally refers to a system of artificially introducing surface water into the groundwater system as a means of storage or recharge. Most typically, this includes the use of *Recharge Wells* which work directly opposite of pumping wells to inject surface water into underlying formations. Depending on the water-bearing formation, these methods may have limited usefulness and are generally better used for pumping water into deep, confined aquifers. (Water Quality) Refers to a system of subsurface disposal of brine effluent into an acceptable formation. Also see *Induced Recharge*.

Injection Well — (1) Refers to a well constructed for the purpose of injection treated wastewater directly into the ground. Wastewater is generally forced (pumped) into the well for dispersal or storage into a designated aquifer. Injection wells are generally drilled into nonpotable aquifers, unused aquifers, or below freshwater levels. (2) (Petroleum Engineering) A well created for injecting water or gas into a formation in secondary recovery, to supply extra energy for driving the remaining oil in the reservoir toward the production wells; also used in pressure-maintenance operations. See *Recharge Well*.

Injection Well Classes [EPA] — Classifications of the *U.S. Environmental Protection Agency (EPA)* that determine the permit requirements of an *Injection Well*.

- [1] **Class I** — A well into which liquid hazardous wastes or other fluids are pumped down, with the fluids being injected into an underground formation below the lowest underground source of drinking water that is within a one-quarter mile radius of the well;
- [2] **Class II** — A well used to dispose of fluids produced by oil and gas wells, to introduce fluids for enhanced oil recovery, or for liquid hydrocarbon storage;
- [3] **Class III** — A well used to pump fluids underground for mineral extraction;
- [4] **Class IV** — A well used to re-inject treated fluid from a superfund cleanup site into or above an underground formation within a one-quarter mile radius of the well (the use of these types of wells is currently banned by the EPA);
- [5] **Class V** — Wells not included in Classes I–IV, mainly shallow industrial disposal wells or *Recharge Wells*. See *Injection Wells, Class V*, below.

Injection Wells, Class V [EPA] — The following table presents a classification and description of Class V injection wells by well type, description, groundwater contamination potential, potential contaminants, and U.S. Environmental Protection Agency (EPA) well code. According to the EPA injection well classification system, Class V injection wells are those wells not falling into one of the following classes: (1) Class I – Injection wells related to hazardous, industrial nonhazardous, and municipal wastewater disposal below the underground sources of drinking water (USDW); (2) Class II – Injection wells related to oil and gas activity; (3) Class III – Injection wells related to mineral extraction; or (4) Class IV – Injection wells related to hazardous and radioactive wastewater disposal into or above USDWs (currently the use of these wells have been banned by the EPA).

Class and Type	Description	Groundwater Contamination Potential	Potential Contaminants	EPA Well Code
DRAINAGE WELLS				
Agricultural Drainage Wells	Receive irrigation tailwaters, other field drainage, animal yard, feedlot, or dairy runoff, etc.	High	Pesticides, nutrients, pathogens, metals transported by sediments, sales.	5F1
Storm Water Drainage Wells	Receive storm water runoff from paved areas, including parking lots, streets, residential subdivisions, building roofs, highways, etc.	Moderate	Heavy metals (Copper, Lead, Zinc) organics, high levels of coliform bacteria. Contaminants from streets, roofs, landscaped areas, herbicides, pesticides	5D2
Improved Sinkholes	Received storm water runoff from developments located in karst topographic areas.	High-Moderate	Variable, pesticides, nutrients, coliform bacteria	5D3
Industrial Drainage Wells	Wells located in industrial areas which primarily received storm water runoff but are susceptible to spills, leads, or other chemical discharges.	High-Moderate	Usually organic solvents, acids, pesticides, and various other industrial waste constituents. Similar to storm drainage wells but usually higher concentrations	5D4

Class and Type	Description	Groundwater Contamination Potential	Potential Contaminants	EPA Well Code
Special Drainage Wells	Used for disposing water from sources other than direct precipitations. Four types reported: landslide control drainage wells, potable water tank overflow drainage wells, swimming pool drainage wells, and lake level control drainage wells	Moderate-Low	Chlorinated and treated water, pH imbalance, algacides, fungicides, muriatic acid	5G30
GEOHERMAL REINJECTION WELLS				
Electric Power Reinjection Wells	Reinject geothermal fluids used to generate electric power—deep wells	Moderate	pH imbalance, minerals and metals in solution (Arsenic, Bromide, Selenium), sulfates	5A5
Direct Heat Reinjection Wells	Reinject geothermal fluids used to provide heat for large buildings or developments—deep wells	Moderate	Hot geothermal brines with TDS between 2,000 to 325,000 mg/l, CO ₃ , CaSO ₄ , Strontium, Barium, Arsenic.	5A6
Heat Pump Air Conditioning Return Flow Wells	Reinject groundwater used to heat or cool a building in a heat pump system—shallow wells	Low	Potable water with temperatures ranging from 90EF to 110EF, may have scale or corrosion inhibitors.	5A7
Groundwater Aquaculture Return Flow Wells	Reinject groundwater or geothermal fluids used to support aquaculture. Non-geothermal aquaculture disposal wells are also included in this category.	Moderate	Used geothermal waters which may be highly mineralized and include traces of arsenic, boron, fluoride, dissolved and suspended solids, animal detritus, perished animals and bacteria.	5A8
DOMESTIC WASTEWATER DISPOSAL WELLS				
Untreated Sewage Waste Disposal Wells	Receive raw sewage wastes from pumping trucks or other vehicles which collect such wastes from single or multiple sources (no treatment).	High	Soluble organic and inorganic compounds including household chemicals. Raw sewage with 99.9% water and 0.03% suspended solid. May contain pathogenic bacteria and viruses, nitrates, ammonia.	5W9
Cesspools	Including multiple dwelling, community, or regional cesspools, or other devices that receive wastes and which must have an open bottom and sometimes have perforated sides. Must serve greater than 20 persons per day if receiving solely sanitary wastes (settling of solids).	High	Soluble organic and inorganic compounds including household chemicals. Raw sewage with 99.9% water and 0.03% suspended solid. May contain pathogenic bacteria and viruses, nitrates, ammonia.	5W10
Septic Systems (Undifferentiated Disposal Method)	Used to inject the waste or effluent from a multiple dwelling, business establishment, community, or regional business establishment septic tank. Must serve greater than 20 persons per day if receiving solely sanitary wastes (primary treatment).	High-Low	Varies with type of system: fluids typically 99.9% water (by weight) and 0.03% suspended solid; major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	5W11
Septic Systems (Well Disposal Method)	Examples include actual wells, seepage pits, cavitettes, etc. The largest surface dimension is less than or equal to the depth dimension. Must serve greater than 20 persons per day if receiving solely sanitary wastes.	High-Low	Varies with type of system: fluids typically 99.9% water (by weight) and 0.03% suspended solid; major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	5W31

Class and Type	Description	Groundwater Contamination Potential	Potential Contaminants	EPA Well Code
Septic System (Drainfield Disposal Method)	Examples include drain or tile lines, and trenches. Must serve more than 20 persons per day if receiving solely sanitary wastes.	High-Low	Varies with type of system: fluids typically 99.9% water (by weight) and 0.03% suspended solid; major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	5W32
Domestic Wastewater Treatment Plant Effluent Disposal Well	Dispose of treated sewage or domestic effluent from small package plants up to large municipal treatment plants	High-Low	Lower levels of organics and bacteria than other septic systems and cesspools.	5W12
MINERAL AND FOSSIL FUEL RECOVERY RELATED WELLS				
Mining, Sand, or Other Backfill Wells	Used to inject a mixture of water and sand, mill tailings, and other solids into mined out portions of subsurface mines whether what is injected is a radioactive waste or not. Also includes special wells used to control mine fires and acid mine drainage wells.	Moderate	Acidic waters	5X13
Solution Mining Wells	Used for <i>in-situ</i> solution mining in conventional mines, such as slope leaching.	Moderate-Low	2.4% sulfuric acid, pH less than 2 for copper and ferric cyanide solution for gold or silver	5X14
In-Situ Fossil Fuel Recovery Wells	Used for in-situ recovery of coal, lignite, oil shale, and tar sands.	Moderate	Steam, air, solvent, igniting agents.	5X15
Spent-Brine Return Flow Wells	Used to reinject spent brine into the same formation from which it was withdrawn after extraction of halogens or their salts.	Low	Variable	5X16

Class and Type	Description	Groundwater Contamination Potential	Potential Contaminants	EPA Well Code
INDUSTRIAL/COMMERCIAL/UTILITY DISPOSAL WELLS				
Cooling Water Return Flow Wells	Used to inject water which was used in a cooling process, both open and closed loop processes.	Low-Moderate	Anti-sealing additives, thermal pollution, potential for industrial spills reaching the groundwater.	5A19
Industrial Process Water and Water Disposal Wells	Used to dispose of a wide variety of wastes and wastewaters from industrial, commercial, or utility processes. Industries include electrical power plants, refineries, chemical plants, smelters, pharmaceutical plants, laundromats and dry cleaners, tanneries, carwashes, laboratories, etc.	High	Potentially any fluid disposed by various industries, suspended solids, alkalinity, sulfate volatile organic compounds.	5W20
Automobile Service Station Disposal Well	Repair bay drains connected to a disposal well. Suspected of disposal of dangerous or toxic wastes.	High	Heavy metals, solvents, cleaners, used oil and fluids, detergents, organic compounds.	5X28
RECHARGE WELLS				
Aquifer Recharge Wells	Used to recharge depleted aquifers and may inject fluids from a variety of sources such as lakes, streams, domestic wastewater treatment plants, other aquifers, etc.	High-Low	Variable: water is generally of good quality	5R21
Saline Water Intrusion Barrier Wells	Used to inject water into fresh water aquifers to prevent intrusion of salt water into fresh water aquifers.	Low	Varies: advanced treated sewage, surface urban and agricultural runoff, and imported surface waters.	5B22
Subsidence Control Wells	Used to inject fluids into a non-oil or gas producing zone to reduce or eliminate subsidence associated with overdraft of fresh water and not used for the purpose of oil or natural gas production.	Low	No specific type of injected fluid noted, similar to aquifer recharge wells.	5S23
MISCELLANEOUS WELLS				
Radioactive Waste Disposal Wells	All radioactive waste disposal wells other than Class IV wells	Unknown	Low-level radioactive wastes.	5N24
Experimental Technology Wells	Wells used in experimental or unproven technologies such as pilot scale in-situ solution mining wells in previously unmined areas.	Low-Moderate	Varies depending on project.	5X25
Aquifer Remediation Related Wells	Wells used to prevent, control, or remediate aquifer pollution, including but not limited to Superfund sites.	Unknown	Nutrients used in biodegradation of organics, oil/grease, phenols, toluene.	5X26
Abandoned Drinking Water Wells	Used for disposal of waste.	Moderate	Potentially any kind of fluid, particularly brackish or saline water, hazardous chemicals and sewage.	5X29
Other Wells	Any other unspecified Class V well.	Unknown	Variable	5X27

Injection Zone — A geological formation receiving fluids through an *Injection Well*.

Injector Water — Service water in which chlorine is added (injected) to form a chlorine solution.

Inland Freshwater Wetlands — Swamps, marshes, and bogs found inland beyond the coastal saltwater wetlands.

Inland Ice — (1) A continental glacier or ice sheet. (2) The ice forming the inner part of either of these structures.

Inland Wetlands — One of two types of wetlands (the other being *Coastal Wetlands*), inland wetlands are most common on floodplains along rivers and streams (riparian wetlands), in isolated depressions surrounded by dry land (for example, playas, basins, and potholes), along the margins of lakes and ponds, and in other low-lying areas where the groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (vernal pools and bogs). Inland wetlands include marshes and

wet meadows dominated by herbaceous plants, swamps dominated by shrubs, and wooded swamps dominated by trees. Certain types of inland wetlands are common to particular regions of the country, for example:

- Bogs and Fens of the northeastern and north-central U.S. and Alaska;
- Wet Meadows or Wet Prairies in the Midwest;
- Inland Saline and Alkaline Marshes and Riparian Wetlands of the arid and semiarid western U.S.;
- Prairie Potholes of Iowa, Minnesota, and North and South Dakota;
- Alpine Meadows of the western U.S.;
- Playa Lakes of the southwest U.S. and the Great Plains;
- Bottomland Hardwood Swamps of the southern U.S.;
- Pocosins and Carolina Bays of the southeast coastal states; and
- Tundra Wetlands of Alaska.

Many of these wetlands are seasonal (i.e., they are dry one or more seasons every year), and, particularly in the arid and semiarid West, may be wet only periodically, for example, during snowpack runoff. The quantity of water present and the timing of its presence in part determine the functions of a wetland and its role in the environment. Even wetlands that appear dry at times for significant parts of the year, for example *Vernal Pools*, often provide critical habitat for wildlife adapted to breeding exclusively in these areas.

Inlet — A recess, such as a bay or cove, along a coast. A stream or bay leading inland, as from the ocean; an estuary. Also, a narrow passage of water, as between two islands. A drainage passage, as to a culvert.

Inline Reservoir — A reservoir constructed in line with the canal used to regulate flow for a balanced operation.

Inorganic — Material such as sand, salt, iron, calcium salts and other mineral materials. Inorganic substances are of mineral origin, whereas organic substances are usually of animal or plant origin. Also see *Organic*.

Inorganic Ions — Minerals present in all waters. Inorganic ions are essential for human health in small quantities, but in larger quantities they can cause unpleasant taste and odor or even illness. Water systems routinely test the mineral content of the water.

Inorganic Matter — Chemical substances of mineral origin, or more correctly, not of basically carbon compounds.

Input Horsepower — The total power used in operating a pump and motor.

Input-Output (Economic Impact) Analysis — (Data Analysis) An analytical technique used to assess economic, fiscal, resource, and environmental impacts to an economic system from a change to one or more economic sectors. The concept of input-output analysis, or economic impact modeling techniques is based on a *mapping*, or detailed delineation, of the economic linkages and financial flows and transactions between and among the various industry sectors of an economy (also see *Standard Industrial Classification [SIC] Codes*). The fundamental premise is that changes in production levels of an economy's basic, or export-oriented, industries, derived from either changes in output or changes in demand, will, through various and extensive inter-industry linkages, result in an iterative process of spending, income creation, and re-spending, thereby changing the production levels of other, directly and indirectly related industries. The input-output process results in a set of *multipliers* which prescribe the total *economic*, *fiscal*, *resource*, or environmental effects for a unit change to a given industry sector. Multipliers may be developed for any factor input which may be measured in terms of a unit of output. Typical *economic impacts* include total economic output, employment, incomes, population, housing units. Typical *fiscal impacts* include tax revenues generated, tax revenue expenditures, and anticipated economic infrastructure requirements. Typical *resource impacts* may include commercial and residential water use, electrical power use, and land use. Typical *environmental impacts* would include water and air pollution effects, and the like. Limitations to the input-output impact analysis technique include its extensive and detailed *Primary Data* requirements (versus *Secondary Data*), the fact that multipliers are derived only for a single point in time, and the assumption of a linear (constant) relationship between inputs and outputs. Even so, this technique represents a robust analytical methodology for assessing near-term impacts on a comprehensive basis.

Insecticide — (1) A chemical used to kill or otherwise control insects. (2) Any substance or chemical formulated to kill or control insects.

Insequent Stream — A stream that has developed on the existing surface, but whose course is seemingly haphazard, being independent of the general form and slope of the surface.

Inset — An inflow, as of water; a channel.

Inset Fan — A special case of the floodplain of a commonly ephemeral stream that is confined between fan remnants, basin-floor remnants, *Ballenas*, or closely opposed fan toeslopes. Its transversely-level cross section is evidence of alluviation of a *Fluve*. It must be wide enough that raw channels cover only a fraction of this component landform's surface.

Inspection — A visual or mechanical check by measuring, boring, or any method necessary to determine the adequacy of construction techniques and the safety and operating performance of a dam.

Instantaneous Discharge — The discharge at a particular instant of time.

Institute for Wetland and Environmental Education and Research (IWEER) — The IWEER is a private educational organization dedicated to providing high-quality technical training to professionals in the environmental sciences and to individuals seeking such positions. Since 1993, the Massachusetts-based IWEER has been training environmental professionals to develop and improve their skills and knowledge for job performance as well as for career advancement. IWEER has assembled a multi-disciplinary faculty of recognized regional and national experts with teaching experience to present a series of short courses on topics relevant to today's environmental professional. Many of the instructors are or have been university professors. All instructors have practical field experience in the subject they are teaching. The IWEER's course offering focuses on wetland-related topics, since wetlands are perhaps the major land-based resource subject to federal and state government regulations throughout the country. If there are other courses that would be of interest, please let us know, because we are

committed to providing high quality courses to meet the needs of today's environmental professionals both in private and public sectors. IWEER is approved by the *U.S. Army Corps of Engineers* to provide training in the use of the *Corps Wetland Delineation Manual* as required for the Corps' Wetland Delineation Certification Program.

Institutional Controls [EPA] — Non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use.

Instream Aeration — The addition of air to a flowing stream to maintain the dissolved oxygen content of the water at an acceptable level.

Instream Flow — (1) The amount of water remaining in a stream, without diversions, that is required to satisfy a particular aquatic environment or water use. (2) Nonconsumptive water requirements which do not reduce the water supply; water flows for uses within a defined stream channel. Examples of instream flows include:

- [1] *Aesthetics* — Water required for maintaining flowing streams, lakes, and bodies of water for visual enjoyment;
- [2] *Fish and Wildlife* — Water required for fish and wildlife;
- [3] *Navigation* — Water required to maintain minimum flow for waterborne commerce;
- [4] *Quality Dilution* — Water required for diluting salt and pollution loading to acceptable concentrations; and
- [5] *Recreation* — Water required for outdoor water recreation such as fishing, boating, water skiing, and swimming.

Also referred to as *Instream Use*.

Instream Flow Needs — Those habitat requirements within the running water *Ecosystem* related to current velocity and depth which present the optimum conditions of density (or diversity) or physiological stability to the aquatic organisms being examined at various life cycle stages.

Instream Flow Requirement — The flow required in a stream to maintain desired instream benefits such as navigation, water quality, fish propagation, and recreation.

Instream Flow Rights — A doctrine used to preserve minimum river or stream flows for fish and wildlife, recreation, water quality, and scenic beauty, among other public purposes. Such rights are limited to the use of water within its natural course, not requiring diversion.

Instream Use — (1) Water uses that can be carried out without removing the water from its source, as in navigation and recreation. (2) Typically, non-consumptive uses of water that do not require diversion from its natural watercourse (e.g., fish and other aquatic life, recreation, navigation, esthetics, and scenic enjoyment). Hydroelectric power production water use is also considered a non-consumptive, but may require temporary diversion from the natural stream flow. Also referred to as *In-Channel Use*, *Nonwithdrawal Use*, or *Instream Flow*.

Insulated Streams — Streams or a reach of a stream that neither contribute water to the zone of saturation nor receive water from it. Such streams are separated from the zones of saturation by an impermeable bed. Also see *Stream*.

Intake — A term for the openings through which water passes into a well. See *Recharge*.

Intake Area — See *Recharge Area*.

Intangible Flood Damage — Estimated damage done by disruption of business, danger to public health, shock, loss of life, and other factors not directly measurable.

Integrated — As applied to design, planning, or operational management, the design, planning, or operation of a system of facilities in an interrelated pattern with view toward maximizing the economies possible in joint operation. An integrated system may be single purpose or multiple purpose, and may be both hydraulic and electrical.

Integrated Drainage — In an arid region, mature drainage characterized by the joining of drainage basins across intervening mountains or ridges as a result of *Erosion* and *Aggradation*.

Integrated Exposure Assessment — A summation over time, in all media, of the magnitude of exposure to a toxic chemical.

Integrated Resource Plan (IRP) — A comprehensive, integrated, interdisciplinary program that represents a coordinated effort of interested stakeholders to determine how best to meet the region's water supply reliability objectives.

Integrated (Water) Resource Planning (IRP) — A comprehensive, interdisciplinary approach to water resource planning that encompasses water resource assessment, demand considerations, analysis of alternatives, risk management, resource diversity, environmental considerations, least-cost analysis, multidimensional modeling, and participatory decision making and public input, among other factors. Integrated Resource Planning begins with specific policy objectives that are applied to extensive lists of options for water supply sources, distribution systems, or other operational requirements. The options are then narrowed after evaluating demand requirements, environmental impacts, conservation options, costs, risks, and other aspects of a project. IRP involves a dynamic process of assessing demand and supply conditions and creatively integrating alternatives and new technologies. While the concepts of IRP are relatively new to the process of water planning, it has been used extensively in the energy industry. As a planning process it helps decision makers select the best mix of water resources, facilities, and conservation measures to meet water demands. In addition to traditional planning techniques, IRP also

- [1] Includes extensive public involvement;
- [2] Considers both supply-side (resources and facilities) and demand-side (conservation) alternatives as ways of meeting demands;
- [3] Considers goals and objectives in addition to dollar costs (e.g., environmental concerns, public acceptability, etc.);
- [4] Considers uncertainty in demand forecasts, regulations, etc.; and
- [5] Considers the effect of water rates on water demands.

Integrator — A device or meter that continuously measures and calculates (adds) total flows in gallons, or million cubic feet, or some other unit of volume measurement. Also called a *Totalizer*.

Intensive Crops — Crops generally grown under irrigation in the Western United States requiring large inputs of labor and capital.

Examples include potatoes, sugar beets, fruit, and corn.

Interbasin Transfer (of Water) — A transfer of water rights and/or a diversion of water (either groundwater or surface water) from one *Drainage* or *Hydrographic Basin* to another, typically from the basin of origin to a different hydrologic basis. Also referred to as *Water Exports* and/or *Water Imports*.

Intercepting Drain — A drain constructed at the upper end of an area to intercept and carry away surface or groundwater flowing toward the area from higher ground. Also referred to as *Curtain Drain*.

Interception (Hydrology) — (1) The process whereby the downward movement of precipitation is interrupted and redistributed. (2) The process by which water from precipitation is collected and stored on the surface of vegetation, from where it eventually evaporates without ever reaching the ground. (3) The water or quantity of water so collected and stored. (4) The amount of water lost to soil moisture by this process, often expressed as a percent. (5) The process of storing rain or snow on leaves and branches which eventually evaporates back to the air. Interception equals the precipitation on the vegetation minus streamflow and throughfall.

Interceptor Sewers — Large sewer lines that, in a combined system, control the flow of sewage to the treatment plant. In a storm, they allow some of the sewage to flow directly into a receiving stream, thus keeping it from overflowing onto the streets. Also used in separate systems to collect the flows from main and trunk sewers and carry them to treatment points.

Interdisciplinary Approach — Addressing problems by means of different methodologies, education, training, and disciplines which, when shared and combined, provide for new, more innovative and more comprehensive solutions.

Interface — (1) The common boundary between two substances such as a water and a solid, water and a gas, or two liquids such as water and oil. (2) A surface which forms the boundary between two geologic strata, two immiscible liquids, or any two phases of matter with distinct boundaries.

Interfan-Valley Drainageway — A drainageway or drainage system rising as on fan drainageways that combine to form a trunk drainageway down the axis of an inter-fan valley, i.e., down the topographic low between two adjacent mountain-front alluvial fans. Fanhead trenches may empty into interfan-valley drainageways. The latter may debouch onto or cross the fan piedmont.

Interference (Wells) — A change in the water level of one well caused by the pumping at another well. The condition occurring when the area of influence of a water well comes into contact with or overlaps that of a neighboring well, as when two wells are pumping from the same aquifer or are located near each other.

Interflow — (1) Lateral movement of water in the upper layer of soil, above the *Water Table*, until the water reaches a stream channel. (2) That movement of water of a given density in a reservoir or lake between layers of water of different density, usually caused by the inflow of water either at a different temperature, or with different silt or salt contents. (3) Runoff due to that part of the precipitation which infiltrates the surface soil (but not to the water table) and moves laterally through the upper soil horizons toward the stream channels. The interflow is included in direct runoff and is part of the *Flood Hydrograph*.

Interfluve — (1) The area between rivers; especially the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. (2) The elevated areas between two *Fluves* (drainageways) that sheds water to them. (3) (Geology) An area of relatively undissected upland between adjacent streams flowing in the same general direction.

Interglacial — (1) Occurring between *Glacial Epochs*. A comparatively short period of warmth during an overall period of *Glaciation*. (2) (Geology) Related to or formed during a period separating successive glacial epochs or two distinct glaciations, characterized by a milder climate in which the *Ice Sheets* melt or retreat.

Interlock — The arrangement or interconnection of the irrigation pump, chemical injection units, and other pumps or supply tanks so that total shutdown of the system will occur if any component malfunctions or fails.

Intermediate Storage Capacity — The volume in acre-feet in the reservoir at the crest of the emergency spillway.

Intermediate Zone — The subsurface water zone below the *Root Zone* and above the *Capillary Fringe*.

Intermittent — (1) A stream that flows only periodically throughout the year. (2) Alternately containing and empty of water as an *Intermittent Lake*.

Intermittent Lake — A lake that contains water for only part of the year rather than the entire year.

Intermittent Spring — A spring that flows periodically, otherwise remaining dry or nonexistent.

Intermittent Stream — (1) A stream which alternates between flow and dry channel. Many intermittent streams are seasonal, but flow in others is aperiodic. (2) A stream that flows only during certain times of the year, as when it receives water from some other source. (3) A stream that occasionally stops flowing, as when more water is lost by evaporation or seepage than is replaced. (4) An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow. (5) A stream that carries water only part of the time, generally in response to periods of heavy runoff either from snowmelt or storms; a stream or part of a stream that flows only in direct response to precipitation. It receives little or no water from springs or other sources. It is dry for a large part of the year, generally more than three months. Flow generally occurs for several weeks or months in response to seasonal precipitation, due to groundwater discharge, in contrast to the *Ephemeral Stream* that flows but a few hours or days following a single storm. Also referred to as *Seasonal Streams*. Also see *Stream*.

Intermittently Exposed — A water regime in wetland classification in which surface water is present throughout the year except in years of extreme drought.

Intermittently Flooded — A water regime in wetland classification in which the substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity.

Intermontane Basin — A generic term for wide structural depressions between mountain ranges that are partly filled with alluvium and are called “valleys” in the vernacular. Intermontane basins may be drained internally (*Bolsons*) or externally (*Semi-Bolsons*).

Intermontane Glacier — An alpine glacier created by the joining of several valley glaciers and lying between mountain ranges or

ridges.

Internal Drainage — (1) Movement of water down through soil to porous aquifers or to surface outlets at lower elevations. (2) Drainage within a basin that has no outlet.

Internal Erosion — (Geology) Any erosion that occurs within a compacting sediment as a result of the movement of water through pores.

Internal Erosion (of a Dam) — The progressive development of erosion by seepage, appearing downstream of the dam as a hole or seam discharging water that contains soil particles. Also referred to as *Piping*.

Internal Friction — Friction within a fluid (water) due to cohesive forces.

Internal Inflow — (Wastewater Treatment) Nonsanitary or industrial wastewaters generated inside of a domestic, commercial or industrial facility and being discharged into the sewer system. Examples are cooling tower waters, basement sump pump discharge waters, continuous flow drinking fountains, and defective or leaking plumbing fixtures.

Internal Soil Drainage — The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are none, very slow, medium, rapid, and very rapid.

International Water Treaty — An agreement between the United States and a foreign nation pertaining to water resources involving both nations. Such treaties supersede state law. Presently, the U.S. has such treaties with Mexico and Canada relating to shared water resources.

Interpluvial — (Geology) (1) Relating to an interval of geologic time during which the climate was drier than that in the *Pluvial* periods preceding or following it. (2) Such an episode or geologic interval.

Interpolate/Interpolation — (Data Analysis) The fitting of data values between observed values. Frequently interpolation will be used when certain periods of data are missing, but data surrounding these missing data values is available. Interpolation techniques must be careful so as to attempt to repeat the patterns of the missing data with respect to trend, seasonality, and longer-term cycles.

Interruptible Water — Water from Municipal Water District (MWD) or other supplier that is subject to being shut off at any time, thus accruing a discounted rate.

Interstadial — (Geology) (1) Long intervals of *Desiccation* occurring between *Pluvial* episodes. (2) Relating to a warmer substage of a glacial stage, during which the ice retreated temporarily.

Interstate Allocation [Nevada and California] — An agreement between the states of Nevada and California over the use of the waters of Lake Tahoe and the Truckee, Carson, and Walker rivers which was ratified by California (1970) and Nevada (1971), but was never ratified by Congress. Despite this, both states have enacted legislation to enforce to the allocation of the Truckee, Carson, and Walker rivers between these two states. Subsequently, in 1990 many of the compact's provisions dealing with the waters of Lake Tahoe and the Truckee and Carson rivers became formalized under *Public Law 101-618* (the *Negotiated Settlement*).

Interstate Carrier Water Supply — A source of water for drinking and sanitary use on planes, buses, trains, and ships operating in more than one state. These sources are federally regulated.

Interstate Water Compact — (1) Broadly, an agreement between two or more states regarding competing demands for a water resource which are beyond the legal authority of one state alone to solve. (2) States administer water rights within their own political boundaries; however, the process becomes more complicated when involving an interstate body of water (*Interstate Water*). Under these conditions there are three possible ways to achieve an interstate allocation of water: (1) A suit for equitable apportionment brought by the states in the U.S. Supreme Court; (2) a Congressional act; and (3) an interstate compact. An interstate compact is an agreement negotiated between states, adopted by their state legislatures, and then approved by Congress. Once an allocation of interstate water is determined by such a means, the individual states may then issue water rights to its share of the water through their normal administrative process. Interstate compacts have been traditionally used in making water allocations in the western states. Also see *Interstate Allocation [Nevada and California]*.

Interstate Waters — According to federal law, interstate waters are defined as: (1) rivers, lakes and other waters that flow across or form a part of state or international boundaries; (2) waters of the Great Lakes; and (3) coastal waters whose scope has been defined to include ocean waters seaward to the territorial limits and waters along the coastline (including inland streams) influenced by the tide.

Interstices — (1) A very small open space in a rock or granular material. Also called a *Void* or *Void Space*. (2) The openings or pore spaces in a rock, soil, and other such material. In the *Zone of Saturation* they are filled with water. Synonymous with void or *Pore*.

Interstitial — Referring to the *Interstices* or pore spaces in rock, soil, or other material subject to filling by water.

Interstitial Monitoring — The continuous surveillance of the space between the walls of an underground storage tank.

Interstitial Pressure — (Hydraulics) The upward pressure of water in the pores or *Interstices* of a material.

Interstitial Water — (1) Water in the pore spaces of soil or rock. (2) Subsurface water contained in the spaces of pores in rock or soil. Also referred to as *Pore Water*.

Intertidal Zone — (Oceanography) (1) That area of coastal land that is covered by water at high tide and uncovered at low tide. (2) The part of the shore that lies between the low and high water lines. Also referred to as the *Littoral Zone*.

Intertropical Convergence Zone — (Meteorology) The axis, or a portion thereof, of the broad trade-wind current of the tropics, occurring as a narrow zone of low pressure somewhat north of the equator, in which air masses originating in the Northern and Southern Hemispheres converge, giving rise to cloudy, showery weather. Also referred to as the *Equatorial Convergence Zone*.

Intervale — (New England) A tract of low-lying land, especially along a river.

Intrabasin Transfer (of Water) — Transfers of water within the same water basin or hydrographic area.

Intramontane Basin — A relatively small structural depression within a mountain range that is partly filled with alluvium and commonly drains externally through a narrower mountain valley.

Intrinsic Permeability — Pertaining to the relative ease with which a porous medium can transmit a liquid under a hydraulic or potential gradient. It is a property of the porous medium and is independent of the nature of the liquid or the potential field.

Intrusive — Where a fluid (e.g., magma) has penetrated into or between other rocks, but has solidified before reaching the surface.

Intrusive Bedrock — (Geology) Denoting igneous rocks in a molten state which have evaded other, older rock formations and cooled below the surface of the earth. These magmas are slow-cooling and form coarse-textured rocks, such as granite.

Intrusive Rocks — Those igneous rocks formed from magma injected beneath the Earth's surface. Generally these rocks have large crystals caused by slow cooling.

Inundate — (1) To cover with water, especially floodwaters. (2) To overwhelm as if with a flood; swamp.

Inundation — (1) The covering by water of lands not normally so covered. (2) The rise and spread of water over land that is not usually submerged.

Inundation Map — A map delineating the area that would be inundated in the event of a dam failure.

Invasive Plant — A plant that moves in and takes over an *Ecosystem* to the detriment of other species; often the result of *Environmental Manipulation*.

Inventory — A scientific survey of natural resources, e.g., plants, animals, water, timber, etc.

Inventorying — Gathering data needed for analyses and evaluation of the status or condition of a specific universe or area of concern.

Inversion — An atmospheric condition where a lower layer of cool air is trapped below an upper layer of warm air. May cause serious air pollution problems.

Invert — The lowest point of the channel inside a pipe, conduit, trench, or canal.

Inverted Siphon — A closed pipeline with its end sections above the middle section, used for crossing under drainage channels, roadways, depressions, or other structures. The term is common but misleading as there is no siphon action involved. Also referred to as a *Sag Pipe*.

Ion — (1) An element or compound that has gained or lost an electron, so that it is no longer neutral electrically, but carries a charge. (2) An atom or molecule that carries a net charge (either positive or negative) because of an imbalance between the number of protons and the number of electrons present. If the ion has more electrons than protons, it has a negative charge and is called an anion; if it has more protons than electrons it has a positive charge and is called a cation. (3) An electrically charged atom, radical (such as SO_4^-), or molecule formed by the loss or gain of one or more electrons. (4) (Water Quality) An electrically charged atom that can be drawn from waste water during electrodialysis.

Ion, Cation, Anion — An ion is an atom of an element containing one or more excess electrons or electrical charges or lacking one or more electrons. If it contains extra electrons, it carries a negative charge and is known as a cation. If deficient in electrons, it is a positively charged anion.

Ion Exchange — The substitution of one *Ion* for another in certain substances. Either *Anion Exchange* or *Cation Exchange* is possible. The most common cation exchange involves the conversion of *Hard Water* to *Soft Water* by means of a *Water Softening* process. Hard water contains the divalent ions of calcium (Ca^{+2}) and magnesium (Mg^{+2}), which cause soap and detergents to form precipitates in water. A *Water Softener* consists of a resin that is saturated with sodium ions (Na^+). As hard water percolates through the resin, the ions of calcium or magnesium are removed as they attach to the resin, thus releasing (being exchanged for) sodium ions.

Ion Exchange Treatment — A common water-softening technique often found on a large scale at water purification plants that remove some organics and radium by adding calcium oxide or calcium hydroxide to increase the pH to a level where the metals will precipitate out.

Ionic Concentration — The concentration of any ion in solution, usually expressed in moles per liter.

Ionic Strength — The weighted concentration of ions in solutions, computed by the formula:

$$\text{Ionic Strength} = \frac{1}{2} \sum (Z_i^2 C_i)$$

where:

Z = the charge on a particular ionic species; and

C = the concentration of a particular ionic species.

Ionization — The splitting or dissociation (separation) of molecules into negatively and positively charged ions.

Ionosphere — The upper layer of the *Atmosphere* above the *Stratosphere*, from a distance of about 80 kilometers (50 miles) from the earth's surface. Incoming solar radiation is sufficiently intense to cause the ionization of the sparse gas molecules present.

Irminger Current — (Oceanography) A terminal branch of the *Gulf Stream* that flows westward south of Iceland, splitting into a branch that continues northward along the west coast of Iceland and another that turns back southwestward to join the East Greenland Current.

Irreversible Effect — An effect characterized by the inability of the body to partially or fully repair injury caused by a toxic agent.

Irrecoverable Losses — Water lost to a salt sink or lost by evaporation or evapotranspiration from a conveyance facility, drainage canal, or in fringe areas of cultivated fields.

Irregularly Exposed — A water regime in wetland classification in which the land surface is exposed by tides less often than daily.

Irregularly Flooded — A water regime in wetland classification in which tidal water alternately floods and exposes the land surface less often than daily.

Irrigable Land — (1) Land capable of being irrigated by any method. (2) (USBR) Arable land under a specific project plan for which irrigation water is, can be, or is planned to be provided and for which facilities necessary for sustained irrigation are provided or are planned to be provided. For the purpose of determining the areas to which acreage limitations are applicable, it is that acreage possessing permanent irrigated crop production potential, after excluding areas occupied by and currently used for homesites, farmstead buildings, and related permanent structures such as feed lots, equipment storage yards, permanent roads, permanent ponds, and similar facilities, together with roads open for unrestricted use by the public. Areas used for field roads, farm ditches and drains, tailwater ponds, temporary equipment storage, and other improvements subject to change at will by the landowner are included in the irrigable acres.

Irrigate — (1) To supply (dry land) with water by means of ditches, pipes, or streams; to water artificially. (2) To wash out (a body cavity or wound) with water or a medicated fluid. (3) To make fertile or vital as if by watering.

Irrigated Acreage — The land area that is irrigated, which is equivalent to total irrigated crop acreage minus the amount of acreage that was multi-cropped.

Irrigated Area — The area upon which water is artificially applied. This excludes farm roads, irrigation ditches, and farmsteads.

Irrigated Crop Acreage — The total amount of land area that is irrigated, including acreage that is double cropped.

Irrigated Cropland — All lands being supplied water by artificial means, excluding waterfowl refuges, that are being used for the production of orchard, field, grain crops and pasture.

Irrigated Land — Land receiving water by controlled artificial means for agricultural purposes from surface or subsurface sources.

Irrigation — (1) The controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall; applying water to soil when rainfall is insufficient to maintain desirable soil moisture for plant growth. (2) The application of water to soil for crop production or for turf, shrubbery, or wildlife food and habitat. (3) The artificial application of water for the purpose of supplying sufficient moisture for plant growth. Disposal of contaminated water is not considered to be irrigation unless other water is use along with the contaminated water. A listing of the types of irrigation systems includes:

- [1] **Center-Pivot** – Automated sprinkler irrigation achieved by automatically rotating the sprinkler pipe or boom, supplying water to the sprinkler heads or nozzles, as a radius from the center of the field to be irrigated. Water is delivered to the center or pivot point of the system. The pipe is supported above the crop by towers at fixed spacings and propelled by pneumatic, mechanical, hydraulic, or electric power on wheels or skids in fixed circular paths at uniform angular speeds. Water is applied at a uniform rate by progressive increase of nozzle size from the pivot to the end of the line. The depth of water applied is determined by the rate of travel of the system. Single units are ordinarily about 1,250 to 1,300 feet long and irrigate about a 130-acre circular area;
- [2] **Drip** – A planned irrigation system in which water is applied directly to the *Root Zone* of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure with the applicators being placed either on or below the surface of the ground;
- [3] **Flood** – The application of irrigation water where the entire surface of the soil is covered by ponded water;
- [4] **Furrow** – A partial surface flooding method of irrigation normally used with clean-tilled crops where water is applied in furrows or rows of sufficient capacity to contain the designed irrigation system;
- [5] **Gravity** – Irrigation in which the water is not pumped but flows and is distributed by gravity;
- [6] **Rotation** – A system by which irrigators receive an allotted quantity of water, not a continuous rate, but at stated intervals;
- [7] **Sprinkler** – A planned irrigation system in which water is applied by means of perforated pipes or nozzles operated under pressure so as to form a spray pattern;
- [8] **Subirrigation** – Applying irrigation water below the ground surface either by raising the water table within or near the root zone or by using a buried perforated or porous pipe system that discharges directly into the root zone;
- [9] **Traveling Gun** – Sprinkler irrigation system consisting of a single large nozzle that rotates and is self-propelled. The name refers to the fact that the base is on wheels and can be moved by the irrigator or affixed to a guide wire;
- [10] **Supplemental** – Irrigation to insure increased crop production in areas where rainfall normally supplies most of the moisture needed;
- [11] **Surface** – Irrigation where the soil surface is used as a conduit, as in furrow and border irrigation as opposed to sprinkler irrigation or subirrigation.

Irrigation Canal – A permanent irrigation conduit constructed to convey water from the source of supply to one or more farms.

Irrigation Conveyance Loss and Waste – The loss of water in transit from a reservoir, point of diversion, or groundwater pump (if not on farm) to the point of use, whether in natural channels or in artificial ones, such as canals, ditches, and laterals.

Irrigation Delivery Requirement, Farm – The amount of water in acre-feet per acre required to serve the irrigated area. It is the crop irrigation requirement plus farm waste and deep percolation.

Irrigation Depletion – The amount of diverted water consumptively used, beneficially and nonbeneficially, in serving a cropped area. It is the gross diversion minus return flow and includes losses due to deep percolation.

Irrigation District — (1) Quasi-political districts created under special laws to provide for water services to property owners in the district. (2) In the United States, a cooperative, self-governing public corporation set up as a subdivision of the state government, with definite geographic boundaries, organized and having taxing power to obtain and distribute water for the irrigation of lands within the district; created under the authority of a state legislature with the consent of a designated fraction of the landowners or citizens and having taxing power. Also see *Truckee–Carson Irrigation District (TCID) [Nevada]*.

Irrigation Efficiency (I.E.) — (1) Basically, the efficiency associated with water application. (2) (Irrigation) The ratio of irrigation

water used in *Evapotranspiration* to the water applied or delivered to a field or farm. This is one of several indices used to compare irrigation systems and to evaluate practices. (3) Generally, the loss of water in transit from a reservoir, point of diversion, or groundwater pump to the point of use, whether in natural channels or in artificial ones, such as canals, ditches, and laterals. More specifically, the percentage of water applied, and which can be accounted for, in the soil-moisture increase for *Crop Consumptive Use*, i.e., the *Crop Requirement*. It is defined as the ratio of the volume of water required for a specific *Beneficial Use* as compared to the volume of water delivered, or applied, for this purpose. It is commonly interpreted as the volume of water stored in the soil for *Evapotranspiration* compared to the volume of water delivered for this purpose, but may be defined and used in different ways. The *Distribution Uniformity (DU)* of a field's irrigation system is one of the limiting factors of a system's irrigation efficiency.

Irrigation Frequency — Time interval between irrigations.

Irrigation Lateral — A branch of a main canal conveying water to a farm ditch; sometimes used in reference to farm ditches.

Irrigation Leaching Requirement — The amount of water required to move residual salts out of the root zone and maintain an adequate soil-salt balance for crop production. Also referred to as *Crop Leaching Requirement*.

Irrigation Period — The number of hours or days that it takes to apply one irrigation to a given design area during the peak consumptive-use period of the crop being irrigated.

Irrigation Pit — A small storage reservoir constructed to regulate or store the supply of water available to the irrigator.

Irrigation Releases — Refers to those waters released from storage primarily for irrigation. Does not include *Precautionary Drawdowns*.

Irrigation Requirement, Crop — The amount of irrigation water in acre-feet per acre required by the crop; the quantity of water, exclusive of precipitation, that is required for production of a specific crop. It is the difference between *Crop Consumptive Use* or *Crop Requirement* and the effective precipitation for plant growth. To this amount the following items, as applicable, are added: (1) irrigation applied prior to crop growth; (2) water required for leaching; (3) miscellaneous requirements of germination, frost protection, plant cooling, etc.; and (4) the decrease in soil moisture should be subtracted.

Irrigation Return Flow — Applied water which is not consumptively used, that is, water that is not transpired, evaporated, or deep percolated into a groundwater basin, and returns to a surface or groundwater supply. In cases of water rights litigation, the definition may be restricted to measurable water returning to the stream from which it was diverted, thereby excluding waters used for deep percolation and salt leaching. Also see *Crop Leaching Requirement* and *Irrigation Leaching Requirement*.

Irrigation Season — The period when irrigation water is delivered for agricultural purposes.

Irrigation Season [Newlands Project, Nevada] — Traditionally, water is delivered to the Newlands Project in Churchill County, Nevada, from March 15th through November 15th, subject to weather conditions and water availability.

Irrigation Structure — Any structure or device necessary for the proper conveyance, control, measurement, or application of irrigation water.

Irrigation, Supplemental — An additional irrigation water supply which supplements the initial, or primary supply.

Irrigation System — Any device or combination of devices having a hose, pipe, or other conduit which connects directly to any source of ground or surface water, through which water or a mixture of water and chemicals is drawn and applied to land or crop or both. The term does not include any handheld hose sprayer or other similar device which is constructed so that an interruption in water flow automatically prevents any backflow to the water source. See *Irrigation*.

Irrigation Systems, Gravity (Surface) — See *Gravity (Surface) Irrigation Systems*.

Irrigation Systems, Pressurized (Piped) — See *Pressurized (Piped) Irrigation Systems*.

Irrigation Systems Tailwater Recovery — A water runoff collection and storage system to provide a constant quantity of water back to the initial system or to another field.

Irrigation Water — Water diverted or pumped for irrigation of crops or pasture. It does not include undiverted water which naturally floods unimproved pastures by overflow during high-runoff years, and water which may beneficially subirrigate land for which no other source of water is diverted.

Irrigation Water Losses — Irrigation water losses are classified as either recoverable or irrecoverable. Recoverable losses may include seepage, leakage, and spillage during storage and conveyance, and surface runoff and deep percolation during irrigation. Irrecoverable losses include evaporation from water and soil surfaces, transpiration from plant leaves into the atmosphere, and return flows to saline groundwater and surface waters that are not available for reuse. Much of the water used in irrigation is classified as recoverable and can be reused, although its quality may be impaired for some uses. Seepage and deep percolation from irrigated fields are potentially recoverable when water percolates below the plant roots and becomes part of the groundwater supply.

Irrigation Water Management — The use and management of irrigation water where the quantity of water used for each irrigation is determined by the water-holding capacity of the soil and the need for the crop, and where the water is applied at a rate and in such a manner that the crop can use it efficiently and significant erosion does not occur.

Irrigation Water Requirement — (1) The quantity, or depth, or water in addition to precipitation, required to obtain desired crop yield and to maintain a salt balance in the crop root zone. (2) The total quantity of water, exclusive of effective precipitation, that is required for crop production, to include crop consumptive use, leaching requirements, and on-farm conveyance losses.

Irrigation Water Use (Withdrawals) — Artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth on recreational lands, such as parks and golf courses. The terms "water use" and "water withdrawals" are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also see *Irrigation Return Flow*.

Island — A land mass, especially one smaller than a continent, entirely surrounded by water. Also see *Biome*.

Islet — A small or minor island.

- Isobar** — A line on a weather map connecting points of equal atmospheric pressure. Also referred to as *Isopestic*.
- Isobath** — (1) An imaginary line on the earth's surface or a line on a map connecting all points which are the same vertical distance above the upper or lower surface of a water-bearing formation or aquifer. (2) (Oceanography) A line that connects points of equal depth on a chart or diagram.
- Isobathytherm** — (Oceanography) A map or chart line that connects points at which the temperature is the same at the same depth.
- Isochrone** — Plotted line graphically connecting all points having the same time of travel for contaminants to move through the saturated zone and reach a well.
- Isoconcentration** — Graphic plot of points having the same contaminant concentration levels.
- Isocyanurate** — Compounds of stabilized chlorine containing a form of cyanuric acid.
- Isodrosotherm** — (Meteorology) A line on a weather chart connecting locations having equal dew points.
- Isohaline** — (Oceanography) (1) Of equal or constant salinity. (2) A chart or map line that connects points of equal salinity.
- Isothermobath** — (Oceanography) In a diagram of a vertical plane in the ocean, a line that connects points at which the temperature is the same.
- Isohyet** — A line drawn on a map connecting points that receive equal amounts of rainfall.
- Isohyetal** — Indicating equal rainfall, generally expressed as lines of equal rainfall.
- Isohyetal Line** — A line drawn on a map or chart joining points that receive the same amount of precipitation. Also referred to as an *Isohyet* and *Isopluvial Line*.
- Isopach** — Of equal thickness; refers to maps in which the shape of a body is indicated by lines drawn through points of equal thickness as projected onto any particular plane.
- Isopestic** — Having, or denoting, equal pressure; *Isobaric*.
- Isopestic Line** — A contour line indicating the *Potentiometric Surface* of an *Aquifer*. Also referred to as *Equipotential Line*.
- Isopleth** — A graph showing the occurrence or frequency of any phenomenon as a function of two variables.
- Isopluvial** — (Meteorology) A line on a weather chart connecting geographical points having the same pluvial, i.e., precipitation, index.
- Isotherm** — A line drawn on a weather map or chart linking all points of equal or constant temperature.
- Isothermy** — In *Limnology*, a state in which a lake is at the same temperature throughout and is well-mixed. Periods of isothermy occur in Spring and Autumn in *Dimictic Lakes*.
- Isotopes** — (1) Alternate form of an element. Elements having same number of protons but different numbers of neutrons in their nuclei. Isotopes have the same atomic number but differing atomic weights. (2) Isotopes are varieties of a chemical element that differ in atomic weight, but are very nearly alike in chemical properties. The difference arises because the atoms of the isotopic forms of an element differ in the number of neutrons in the nucleus. For example, ordinary chlorine is a mixture of isotopes having atomic weights of 35 and 37, and the natural mixture has an atomic weight of about 35.543. Many of the elements similarly exist as mixtures of isotopes, and a great many new isotopes have been produced in the operation of nuclear devices such as the cyclotron. There are 275 isotopes of the 81 stable elements, in addition to more than 800 radioactive isotopes (*Radioisotopes*).
- Isotropic** — (1) Said of a medium whose properties are the same in all directions. (2) The condition in which the hydraulic properties of interest of the aquifer are the same in all directions.
- Isotropy** — That condition in which a medium has the same properties in all directions.
- Isthmus** — A narrow strip of land connecting two larger masses of land.
- Izaak Walton** — An English biographer, who is best known for *The Compleat Angler* (1653), a classic guide to the joys of fishing, with over 300 new printings. The book combines practical information about angling with folk lore. The story of three friends, traveling through the English countryside, is enlivened by occasional songs, ballads, quotations from several writers, and glimpses of an idyllic and now lost rural life. "Indeed, my good scholar, we may say of angling, as Dr. Boteler said of strawberries, "Doubtless God could have made a better berry, but doubtless God never did"; and so, if I might be judge, God never did make a more calm, quiet, innocent recreation than angling." (from *The Compleat Angler*, 1653-1655). *The Compleat Angler* was a combination of manual and meditations. It became one of the most reprinted books in the history of British letters. The story on three sportsmen, a fisherman (Piscator, who is Walton himself), a huntsman (Venator), and a fowler (Auceps). They travel along the river Lea on the first day in May and discuss the relative merits of their favorite pastimes. Auceps tells that "the very birds of the air, those that be not Hawks, are both so many and so useful and pleasant to mankind, that I must not let them pass without some observations. They both feed and refresh him; feed him with their choice bodies, and refresh him with their heavenly voices." On his own turn Venator defends hunting: "Hunting trains up the younger nobility to the use of manly exercises in their riper age. What more manly exercise than hunting the Wild Boar, the Stag, the Buck, the Fox, or the Hare? How doth it preserve health, and increase strength and activity!" And finally Piscator reminds his friends: "I might tell you that Almighty God is said to have spoken to a fish, but never to a beast; that he hath made a whale a ship, to carry and set his prophet, Jonah, safe on the appointed shore."
- Izaak Walton League of America (IWLA)** — The mission of the Izaak Walton League of America is to conserve, maintain, protect and restore the soil, forest, water and other natural resources of the United States and other lands; to promote means and opportunities for the education of the public with respect to such resources and their enjoyment and wholesome utilization. The League was founded in 1922 as a national organization of hunters, anglers, and other conservation-minded outdoor enthusiasts who work through volunteer, community-based action and education programs to ensure the sustainable use of America's natural resources. With 50,000 members and supporters, the League offers a variety of ways for people to get involved including Save Our Streams (SOS), a hands-on program that teaches youths and adults how to monitor and protect streams throughout the country. Other IWLA programs focus on natural resources advocacy through state and federal legislation, outdoor ethics for

recreationists, community sustainability, energy efficiency and sustainable agricultural practices. The League is first and foremost an organization of active and dedicated volunteer conservationists who help protect and restore the country's natural resources at the local, state and national levels. The League has divisions in 21 states (Alaska, California, Colorado, Florida, Illinois, Indiana, Iowa, Maryland, Michigan, Minnesota, Nebraska, New York, Ohio, Oregon, Pennsylvania, South Dakota, Virginia, Washington, West Virginia, Wisconsin, and Wyoming) and more than 300 local chapters located in 32 states. The conservation accomplishments of IWLA local, state and at-large members, often referred to as Ikes, span more than seven decades. These League members have made contributions large and small, from helping pass the Alaska National Interest Lands Conservation Act to providing hunter education and safety training to a new generation of hunters. During the 1920's and 1930's, division and chapter members helped establish nonpartisan state game commissions or conservation departments in several states. League state and local groups during this era also were instrumental in securing some of the country's first municipal wastewater treatment facilities. Later, during the 1950's and 1960's, these groups started local programs that later became national initiatives aimed at controlling soil erosion, reducing highway litter, and protection local stream water quality. Today, the League's chapters and divisions are continuing this tradition of conservation leadership, organizing statewide stream monitoring programs, outdoor ethics campaigns, youth education promotions and wetlands protection efforts, among other projects. They also are involved with many of the country's major conservation events including Arbor Day, Earth Day, National Fishing Week, and National Hunting and Fishing Day. Many IWLA chapters which own or lease facilities have nature trails, fishing ponds, shooting ranges, or other attractions. These chapters are able to provide outdoor recreation and educational opportunities to members with a wide range of interests, abilities, and special needs. The League was named after Izaak Walton, an English biographer who is best known for *The Compleat Angler* (1653), a classic guide to the joys of fishing, with over 300 new printings. This famous literary work combines practical information about angling with folk lore and became one of the most reprinted books in the history of British letters.

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J

Jackson Turbidity Unit (JTU) — The JTU is a measurement of the turbidity, or lack of transparency, of water. It is measured by lighting a candle under a cylindrical transparent glass tube and pouring a sample of water into the tube until an observer looking from the top of the tube cannot see the image of the candle flame. The number of JTU's varies inversely and nonlinearly with the height of the sample (e.g., a sample which measures 2.3 cm has a turbidity of 1,000 JTU's whereas a sample measuring 72.9 cm has a turbidity of 25 JTU's).

Jar Test — (1) A laboratory procedure that simulates a water treatment plant's coagulation/flocculation units with differing chemical doses, mix speeds, and settling times to estimate the minimum or ideal coagulant dose required to achieve certain water quality goals. (2) A laboratory procedure that simulates a water treatment plant's coagulation and/or flocculation units with differing chemical doses and also energy of rapid mix, energy of slow mix, and settling time. The purpose of this procedure is to estimate the minimum or ideal coagulant dose required to achieve certain water quality goals. Samples of water to be treated are commonly placed in six jars. Various amounts of chemicals are added to each jar, and the settling of solids is observed. The dose of chemicals that provides satisfactory settling removal of turbidity and/or color is the dose used to treat the water being taken into the plant at that time. When evaluating the results of a jar test, the operator should also consider the floc quality in the flocculation area and the floc loading on the filter.

Jet — A forceful stream of fluid (as water or gas) discharged from a narrow opening or a nozzle.

Jet Stream — (Meteorology) (1) A concentration of relatively strong winds within a narrow stream in the atmosphere, especially a quasi-horizontal concentration of strong westerly winds in the high *Troposphere*. (2) In upper-level charts, a similar concentration of winds having a speed of 50 knots or greater. (3) Relatively strong winds concentrated in a narrow stream in the atmosphere normally referring to quasi-horizontal high-altitude winds. The position of jet streams vary from day to day and week to week. General weather patterns are related closely to the position and strength of the jet stream(s). The two main high-altitude jet streams which usually affect the U.S. are the polar and subtropical jet streams. (4) A high-speed, meandering wind current, generally moving from a westerly direction at speeds often exceeding 400 kilometers (250 miles) per hour at altitudes of 15 to 25 kilometers (10 to 15 miles). In the Western United States, the jet stream's north-south latitudinal position largely determines the application and intensity of precipitation during the winter months when most rain and snowfall occur. Also see *Low-Level Jet (Stream)*.

Jetty — A structure extending into a sea, lake, or river to influence the current or tide, in order to protect harbors, shores, and banks.

Jevons Effect — (Meteorology) The effect upon the measurement of rainfall caused by the presence of the rain gauge itself, in which the gauge disturbs the flow of air that passes it, carrying away a portion of the rain that would normally be collected. This effect is a function of the wind speed and the height of the gauge from the ground. This phenomenon was first described in 1861 by W. S. Jevons.

Jig — An apparatus for cleaning or separating crushed ore by agitation in water.

Joint — A surface that divides a rock and along which there has been no visible movement parallel to the surface.

Joint-Use Capacity — That reservoir capacity which has been assigned to flood control purposes during certain periods of the year and to other purposes during other periods of the year.

Joint-Use Storage — Reservoir storage space which is used for more than one purpose. The operation may follow a fixed predetermined schedule or may be flexible and subject to adjustment, depending upon particular hydrologic conditions.

Joule — A unit of energy or work equivalent to one watt per second, 0.737 foot-pounds, or 0.238 *Calories*, or 9.484×10^{-4} *British Thermal Unit (BTU)*.

Junior (Water) Rights — A junior water rights holder is one who holds rights that are temporarily more recent than senior rights holders. All water rights are defined in relation to other users, and a water rights holder only acquires the right to use a specific quantity of water under specified conditions. Therefore, when limited water is available, junior rights are not met until all senior rights have been satisfied. See *Prior Appropriation Doctrine*.

Jurisdictional Wetland [Corps/EPA/NRCS] — (1) A *Wetland* over which federal or state agencies have regulatory authority. Wetlands are included under surface water quality regulations, pesticide regulations, and landfill regulations in many states. Two federal agencies oversee wetland issues: (a) the U.S. Department of Agriculture *Natural Resources and Conservation Service (NRCS)* has jurisdiction over wetlands on "Agricultural Lands;" (b) the *U.S. Army Corps of Engineers [Corps]* and the *U.S. Environmental Protection Agency (EPA)* have jurisdiction over "waters of the United States, including wetlands." These responsibilities are defined in the *Clean Water Act (CWA) Section 404* and *Swampbuster* sections. (2) Those areas that meet the criteria established by the EPA for delineating wetlands and are considered to be waters of the United States. (3) A wetland that falls under the jurisdiction of Section 404 of the Clean Water Act of 1977. Specifically, an area that meets the definitional requirements for wetlands as determined by the Corps of Engineers. An area must possess all three required parameters - vegetation, soils, and hydrology - to be considered a jurisdictional wetland. Only the Corps of Engineers can legally determine whether an area is a jurisdictional wetland. Specific determinants are:

- [1] **Vegetation** – a jurisdictional wetland has hydrophytic vegetation which is identified and published for local areas

in the U.S. by the *U.S. Fish and Wildlife Service (USFWS)*;

- [2] **Soils** – a jurisdictional wetland has *Hydric Soils* which are delineated and listed by the Natural Resources and Conservation Service and published for each county in the U.S.; and
- [3] **Hydrology** – a jurisdictional wetland must exhibit wetland hydrology, specifically, the presence of surface or sub-surface water.

Also see *Wetland Delineation*.

Juvenile — (Volcanology) Of pyroclastic material or water, derived directly from magma.

Juvenile Water — (1) Water brought to the surface or added to underground supplies from magma. (2) Water contained in ore derived from magmatic rock and thought to have come to the surface for the first time.

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K

Kame — (1) A conical hill or short irregular ridge of gravel or sand deposited in contact with glacial ice. (2) (Geology) A long, low, steep-sided mound, *Hummock*, or irregular ridge, consisting of poorly stratified *Fluvioglacial* drift that is primarily sand and gravel, and deposited as an alluvial fan or a delta at the terminal edge of a melting *Glacier*.

Kame Delta — See *Delta Kame*.

Kame Moraine — (Geology) (1) An end moraine containing numerous low mounds or irregular ridges of stratified sand and gravel. (2) A group of such mounds or ridges along the front of a stagnant *Glacier*.

Kame Terrace — (Geology) A steep-sided, terrace-like ridge, largely stratified gravel and sand, formed by a meltwater stream flowing between a melting *Glacier* or stagnant ice lobe and a higher valley wall or other higher ground and remaining after the ice disappears. Also referred to as an *Ice-Contact Terrace* or *Ice-Marginal Terrace*.

Kansan — (Geology) Of or relating to one of the glacial stages of the *Pleistocene* epoch which occurred in North America, which consisted of the *Nebraskan* (first stage), *Kansan* (second stage), *Illinoian* (third stage), and *Wisconsin* (fourth stage).

Kaolinite — A common clay mineral. A two-layer hydrous aluminum silicate, $\text{Al}_2(\text{Si}_2\text{O}_5)(\text{OH})_4$.

Karst, also Karstic Region — (Geology) (1) A landscape characterized by numerous sinkholes, caves, and extensive underground drainage that is produced on limestone, gypsum, or dolomite formations by solution or dissolution. (2) Limestone and dolomite areas with a topography peculiar to and dependent on underground solution and the diversion of surface waters to underground routes. Characteristic of an area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams, and caverns. Also referred to as *Karst Topography*.

Karst Activity (Geoindicator) [GCRI0] — It is estimated that karst landscapes occupy up to 10 percent of the Earth's land surface, and that as much as a quarter of the world's population is supplied by karst water. The karst system is sensitive to many environmental factors. The presence and growth of caves may cause short-term problems, including bedrock collapse, disparities in well yields, poor groundwater quality because of lack of filtering action, instability of overlying soils, and difficulty in designing effective monitoring systems around waste facilities. Instability of karst surfaces leads annually to millions of dollars of damage to roads, buildings and other structures in North America alone. Radon levels in karst groundwater tend to be high in some regions, and underground solution conduits can distribute radon unevenly throughout a particular area. Because the great variety of subsurface voids and deposits are protected from surface weathering and disturbance, karst preserves a record of environmental change more faithfully than most other geological settings. Temperature, rainfall, nature of soil and vegetation cover, glaciation, fluvial erosion and deposition, and patterns of groundwater flow can usually be read from cave patterns and deposits. This record can be resolved on an annual scale in the case of certain fast-growing speleothems. Karst is a type of landscape found on carbonate rocks (limestone, dolomite, marble) or evaporites (gypsum, anhydrite, rock salt) and is typified by a wide range of closed surface depressions, a well-developed underground drainage system, and a paucity of surface streams. The highly varied interactions among chemical, physical and biological processes have a broad range of geological effects including dissolution, precipitation, sedimentation and ground subsidence. Diagnostic features such as sinkholes (dolines), sinking streams, caves and large springs are the result of the solutional action of circulating groundwater, which may exit to entrenched effluent streams. Most of this underground water moves by laminar flow within narrow fissures, which may become enlarged above, at or below the water table to form subsurface caves, in which the flow may become turbulent. Caves contain a variety of dissolution features, sediments and speleothems (deposits with various forms and mineralogy, chiefly calcite), all of which may preserve a record of the geological and climatic history of the area. Karst deposits and landforms may persist for extraordinarily long times in relict caves and paleokarst. Karst can be either a sink or a source of CO_2 , for the karst process is part of the global carbon cycle in which carbon is exchanged between the atmosphere, surface and underground water and carbonate minerals. Dissolution of carbonates, which is enhanced by the presence of acids in water, ties up carbon derived from the rock and from dissolved CO_2 as aqueous HCO_3^- . Deposition of dissolved carbonate minerals is accompanied – and usually triggered – by release of some of the carbon as CO_2 . In many karst locations, CO_2 emission is associated with the deposition of calcareous sinter (tufa, travertine) at the outlet of cold or warm springs. See *Geoindicators [U.S. Global Change Research Information Office]*.

Karst Hydrology — The branch of *Hydrology* that deals with the hydrology of geological formations having large underground passages or fractures which enable underground movement of large quantities of water.

Karst Plain — (Geology) A plain of nearly horizontal limestone strata on which karst features develop. Also referred to as a *Karst Plateau*.

Karst Topography — The structure of land surface resulting from limestone, dolomite, gypsum beds, and other rocks formed by dissolution and characterized by closed depressions, sinkholes, caves, and underground drainage.

Karstic River — A river which originates from a karstic spring or flows in a *Karst* or *Karstic Region*.

Keeper — In terms of river navigation, a *Reversal* that is capable of trapping a raft for long periods. Similar to but more powerful than a *Stopper*.

Kelly — Hollow steel bar that is the main section of drill string to which the power is directly transmitted from the rotary table to

rotate the drill pipe and bit.

Kelpie, also Kelpy — A malevolent water spirit of Scottish legend, usually having the shape of a horse and rejoicing in or causing drownings; a water sprite of Scottish folklore that delights in or brings about the drowning of wayfarers.

Kelvin (K) — The *SI Unit* of temperature. The base unit of temperature in the International System of Units that is equal to 1/273.16 of the Kelvin scale temperature of the triple point of water. Zero Kelvin is *Absolute Zero*, and an interval of 1 K is equal to 1E on the *Celsius Scale* (*Centigrade Temperature Scale*) and 1.8E on the *Fahrenheit Temperature Scale*. 0EC = 273.15 K.

Kelvin Scale — An absolute scale of temperature in which each degree equals one kelvin (K). Water freezes at 273.15 K and boils at 373.15 K.

Kelvin Wave — (Oceanography) A tidal phenomenon caused by the *Coriolis Effect* in certain relatively confined bodies of water (for example, the North Sea). The tidal “bulge” is higher to the right of the direction of advance in the Northern Hemisphere, while in the Southern Hemisphere it is higher to the left.

Kernel Ice — A very irregular, opaque, low-density ice that forms on aircraft at sub-freezing temperatures.

Kesterson Reservoir [California] — Kesterson Reservoir, located in Merced County in the Central Valley of California, became famous (or infamous as the case may be) in the early 1980's as a site of selenium (Se) toxicity to waterfowl as a result of the reservoir storage of selenium-enriched agricultural drainwater. Elevated environmental selenium in the reservoir was responsible for significant losses among aquatic bird species. The loss of aquatic wildlife brought to national attention the real and potential environmental exposure to wildlife from agricultural drainwater, particularly in the western United States where these waters are generally derived from irrigation water runoff. This incident significantly enhanced the public's awareness and appreciation for the hazards of constituent (chemical) loading of agricultural water runoff. In particular, it was recognized how non-toxic loading levels in runoff waters can become concentrated to toxic levels in terminus locations, e.g., terminal lakes, wetlands, constructed reservoirs and holding ponds, sinks, playas, etc, especially during periods of high evaporation. The eventual solution to the problem at Kesterson Reservoir required halting new sources of drainwater, followed by draining and partially filling the reservoir to convert it to terrestrial habitat (with off-site mitigation for lost wetlands habitat). Kesterson was thereby transformed into an upland habitat, utilized by terrestrial avian species, including migratory and resident raptors. The goal was the elimination of wildlife exposure to toxic levels of selenium through aquatic pathways. Following this transformation, reproductive impairment has not been observed in terrestrial birds at Kesterson. Originally, Kesterson Reservoir was the terminal evaporation pond for agricultural drainage waters from the west side of the San Joaquin Valley. Recently developed agricultural fields about 85 miles to the south were the source area for this drainage. Prior to development of the Central Valley, there was very little leaching of the soil; however, after agriculture and irrigation became the mainstay in the San Joaquin Valley it became necessary to remove, i.e., drain off, the salts that had now mobilized through extensive irrigation practices. Salts and trace elements that had taken thousands of years to accumulate in an 86,000-acre source area leached out of approximately 8,000 acres of that land and concentrated in Kesterson's 1,200 acres in a matter of four or five years. The 8,000 acre feet, or 10 million cubic meters of water, that Kesterson received each year contained about 300 micrograms per liter of selenium; the drinking water standard is 10 micrograms per liter. At first, the U.S. Bureau of Reclamation and California's Department of Water Resources planned to merely discharge the salty water drainwaters into a 120-mile central drainage canal, the San Luis Drain, diverting it northward and disposing of it in the San Joaquin-Sacramento River Delta. But, with the prospect of adding more contaminants to an already polluted San Francisco Bay, funding and political support quickly evaporated. Instead, the flow of drainage water was stopped at Kesterson's 12 ponds, which in the original plan were meant to be a series of temporary holding ponds. In 1986, the U.S. Department of the Interior decided to close the San Luis Drain, effectively cutting off inflows of selenium and salts into Kesterson. Even so, periodic flooding caused the formation of selenium-concentrated pools, still deadly to aquatic wildlife. Ultimately decided upon was a very “low-tech” solution – to raise the level of the ground surface so no selenium-concentrated pools could form. The U.S. Bureau of Reclamation and the California Water Resources Control Board brought in a million cubic yards of clean soil from the surrounding area, enough to cover about half of Kesterson, and especially the low-lying areas, 15 to 30 centimeters deep. The soil cover dealt with the acute problem of water formation. What remained was the potential long-term hazard to wildlife. That long-term solution involves continual monitoring soil water and groundwater and periodically sampling seasonal pool waters to gain a clearer picture of long-term patterns.

Kettle — (Geology) (1) A depression left in a mass of *Glacial Drift*, formed by the melting of an isolated block of glacial ice. (2) A steep-sided, basin-like depression in glacial drift deposits, probably formed when a slowly melting, large ice block left by a retreating glacier was subsequently buried by newer deposits, causing the overlying layers to collapse. Also referred to as *Kettle Hole* or *Kettle Basin*. Also see *Pothole*.

Keyway (Key) — The notch excavated into the side of a gully or stream to anchor a check dam or other structure.

KG (kg) — Kilogram.

KGAL — A thousand gallons (kilogallons).

Kibble — An iron bucket used in wells or mines for hoisting water, ore, or refuse to the surface.

Kieselguhr — A fine, powdered diatomaceous earth used in industry as a filler, a filtering agent, and absorbent, a clarifier, and an insulator. More commonly referred to as *Diatomite*.

Kilo — (1) Kilogram. (2) Kilometer. (3) A prefix meaning “thousand” used in the metric system and other scientific systems of measurement.

Kilogram — The base unit of mass in the International System of Units that is equal to the mass of a prototype agreed upon by international convention and that is nearly equal to 1,000 cubic centimeters of water at the temperature of its maximum density. Also see *Metric System*.

Kilowatt (Kw) — The electrical unit of power which equals 1,000 watts or 1.341 horsepower. Since one watt equals one *Joule* per second, a kilowatt equals 1,000 joules per second. The *Kilowatt-Hour (KWH)* is the basic unit of electric energy. It equals 1

kilowatt of power applied for 1 hour.

Kilowatt–Hour (Kwh) — A unit of electrical energy equal to 1,000 watt-hours or a power demand of 1,000 watts for one hour. The equivalent of 3,600,000 *Joules*. Power company utility rates are typically expressed in cents per kilowatt-hour.

Kinematic Viscosity — The ratio of dynamic viscosity to mass density. It is obtained by dividing dynamic viscosity by the fluid density. Units of kinematic viscosity are square meters per second.

Kinetic Energy (k) — (1) The energy inherent in a substance because of its motion, expressed as a function of its velocity and mass, or $MV^2/2$. (2) Energy possessed by a moving body of matter, such as water, as a result of its motion.

Kinetic Rate Coefficient — A number that describes the rate at which a water constituent such as a *Biochemical Oxygen Demand (BOD)* or *Dissolved Oxygen (DO)* rises or falls.

Kjeldahl Nitrogen — Nitrogen in the form of organic proteins or their decomposition product ammonia, as measured by the Kjeldahl Method.

Knifing — A means to incorporate slurry or liquid manures into the soil. The waste is injected just behind a thin, knifelike tool that opens a narrow slit in the soil.

Known Geothermal Resource Areas (KGRA) — Basically, KGRAs fall into two categories: (1) areas of obvious geothermal activity such as hot springs designated by the *U.S. Geological Survey (USGS)*; and (2) areas where applications to lease overlap to such a degree as to indicate strong geothermal potential. The latter are called competitive interest KGRAs.

Krill — Small abundant crustaceans that form an important part of the food chain in Antarctic waters.

Kymatology — (Oceanography) The study of waves and wave motion.

Kyrohydratic Point — (Oceanography) The eutectic temperature of a salt; the temperature of crystallization of a salt in brine enclosed by frozen seawater.

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La Niña — (Oceanography and Meteorology) [From the “little girl”] The name given to the weather phenomenon characterized by abnormally cold ocean surface water temperatures in the eastern Pacific Ocean near the equator. According to the *National Oceanic and Atmospheric Administration (NOAA)*, during a La Niña event, temperatures are typically warmer than normal in the southeast United States and cooler than normal in the northwest, bringing drier than normal conditions to southern California and the Southwest U.S. With the cold water in the Pacific tropics characterizing a La Niña event, the chill, west-to-east high-altitude winds known as the jet stream no longer move southward attracted by the temperature differential which exists during the El Niño warm-water event. Therefore, instead of being “pulled” downward as the jet stream hurls across the United States, it tends to shift northward, producing unusually wet springs in the Northwestern U.S. and summer droughts in the mid-Atlantic region. It also means that there are no strong upper elevation winds in the middle Atlantic to blow the tops off of any big tropical storms forming, consequently allowing for the formation of more hurricanes.

Laboratory Blank — An artificial sample, usually distilled water, introduced to a chemical analyzer to observe the response of the instrument to a sample that does not contain the material being measured. The blank can also detect any contamination occurring during laboratory processing of the sample.

Lacustrine — Pertaining to, produced by, or inhabiting a lake. Of, related to, produced by, or inhabiting lakes as in lacustrine fauna, lacustrine terrace, and lacustrine sand.

Lacustrine Deposits — Stratified materials deposited in lake waters and later become exposed either by the lowering of the water level or by the elevation of the land.

Lacustrine Wetlands — According to criteria of the *U.S. Fish and Wildlife Service (USFWS)*, *Lacustrine Wetlands* are greater than 20 acres and have less than 30 percent cover of persistent vegetation. Also see *Wetlands*. See *Wetland and Deepwater Habitat Classification System* and more detailed information on these systems.

Lacustrine Zone — Area of a reservoir which is most lake-like; current velocities are much slower than for riverine or transitional zones. Little sediment deposition normally occurs since most sediment load has been deposited in the riverine or transitional zones; may thermally stratify; primary productivity predominates.

Lade — To take up or remove water with a ladle or dipper.

Lag (Time) — (Statistics) The difference in time units of a series value and a previous series value. In time series analysis, the lag typically represents the period of time between the change in the independent or predictor (*Exogenous*) variable and its strongest (most significant) effect on the dependent or predicted (*Endogenous*) variable. Also see *Lead (Time)*.

Lag Deposits — In valley sediment deposition, lag deposits consist of the segregation of larger or heavier particles, more persistent than transitory channel deposits, and including heavy mineral placers. See *Valley Sediment Deposits*.

Lagged Endogenous Variable — (Statistics) Refers to the use of a prior-period *Dependent Variable* used as an *Explanatory Variable* in the current period. The model below uses a prior *Endogenous* value, Y_{t-1} , to explain the behavior of Y_t :

$$Y_t = \phi_1 Y_{t-1} + \delta + \epsilon_t$$

In many instances of social, economic, and natural phenomenon, the behavior of a variable in the current period may be dependent upon or somehow influenced by its prior behavior or level. This constitutes the fundamental underpinning of an *Autoregressive Process* in the analysis of *Time-Series Data*.

Lagoon — (1) A shallow lake or pond, especially one connected with a larger body of water. (2) A marsh, shallow pond, or lake, especially one into which the sea flows. (3) The area of water enclosed by a circular coral reef, or atoll. (4) An area of shallow salt water separated from the sea by sand dunes. (5) A metaphorical term for the ponding area behind a Pleistocene offshore or barrier bar (beaches) that collects fine textured sediments. (6) (Water Quality) Lagoons are scientifically constructed ponds in which sunlight, algae, and oxygen interact to restore water to a quality equal to effluent from a secondary treatment plant. (7) (Wastewater) With respect to “factory farms,” the term lagoon means an open-air pit filled with liquid and solid waste. Some lagoons are larger than seven acres and contain as much as 20 to 45 million gallons of wastewater and related solids. The waste is collected with scrapers, flushing systems, or gravity flow gutters, and then stored in open-air lagoons. Opportunities for environmental and ecological damage are very real. For example, the lagoons can leak or rupture, or they can be filled too high and overflow with heavy rainfall. But even if none of these problems occur, the lagoons still release harmful and noxious gases. Also see *Sprayfield*.

Lagoon System — (Water Quality) A system of scientifically construction Lagoons or ponds in which sunlight, algae, and oxygen interact to restore water to a quality equal to effluent from a *Secondary Treatment Plant*.

Lag Time, also Lagtime — (1) The time from the center of a *Unit Storm* to the peak discharge or center of volume of the corresponding *Unit Hydrograph*. (2) (Flood Irrigation) The period between the time that the irrigation stream is turned off at the upper end of an irrigated area and the time that water disappears from the surface at the point or points of application.

Lahar — A mudflow composed of volcanic debris and water.

(Lake) Lahontan — See *Lake Lahontan*.

Lahontan Basin — A major basin within the *Great Basin* that is fed by the Truckee, Carson, Walker, Susan, Quinn and Humboldt Rivers. It has a drainage or hydrologic area of about 45,000 square miles and during the Pleistocene Epoch (11,000 years B.P. to approximately 1.8 million years B.P.) Contained the 8,600 square mile Lake Lahontan. The Lahontan basin encompasses much of northern Nevada and parts of eastern California and southern Oregon.

Lahontan Cutthroat Trout (LCT) — *Oncorhynchus clarki henshawi*. An inland subspecies of cutthroat trout endemic to the physiographic Lahontan basin of northern and central Nevada, eastern California, and southern Oregon.

Lahontan Valley Environmental Alliance (LVEA) [Nevada] — An association of Lahontan Valley (Churchill County, Nevada) entities formed in October 1993 to represent the broad-based concerns and issues of the Newlands Irrigation Project's residents including quality of life, water quality and quantity, municipal and industrial water supply, and land-use planning issues. The LVEA membership includes the City of Fallon, Town of Fernley, Churchill County, Truckee-Carson Irrigation District (TCID), Lahontan Conservation District and the Stillwater Conservation District.

Lahontan Valley Wetland System [Nevada] — An extensive wetland system in northwestern Nevada in Churchill County near the City of Fallon encompassing the *Stillwater Wildlife Management Area* and the *Stillwater National Wildlife Refuge*, as well as the Carson Lake and Carson Pasture, which serves as a key migration and wintering area for up to 1 million waterfowl, shorebirds, and raptors. Each spring and fall, it hosts a significant percentage of the Pacific Flyway's migratory birds. The Lahontan Valley Wetland System was named to the Western Hemisphere Shorebird Reserve Network in 1988, and it has been nominated for inclusion under the Convention of Wetlands of International Importance, attesting to the continental significance of this invaluable resource. By one estimate, in the early 1900s the Lahontan Valley Wetland System alone contained about 85,000 acres (34,400 ha) of wetlands visited by millions of waterfowl and shorebirds using the eastern edge of the Pacific Flyway during migration. With the advent of the *Newlands Project*, fresh water that traditionally charged the wetlands was replaced by a greatly diminished supply of agricultural drain water. Overall, wetland acreage in the Lahontan Valley declined by 85 percent. Because it is one of only three large interior basin wetland systems along the west coast, deterioration of Lahontan Valley wetlands has already markedly reduced the carrying capacity of the Pacific Flyway. In 1990, Congress passed *Public Law 101-618* (the *Negotiated Settlement*) authorizing the purchase and transfer of enough water rights to maintain a total of 25,000 acres of primary wetlands in the Lahontan Valley. The U.S. Department of the Interior, Fish and Wildlife Service (USFWS) estimates this will require up to 125,000 acre-feet of water annually. Also see *Newlands Project [Nevada]* and *Public Law 101-618 [Nevada]*.

Lake — (1) A considerable body of inland water or an expanded part of a river. (2) An extensive body of standing fresh or salt water that occupies a depression in the earth's surface and is more or less surrounded by land. (3) body of fresh or salt water of considerable size, whose open-water and deep-bottom zones (no light penetration to bottom) are large compared to the shallow-water (shoreline) zone, which has light penetration to its bottom.

Lake Ball — (Ecology) A spherical mass of filamentous material composed of living or dead vegetation, sand, and fine-grained minerals, produced on a lake bottom by the action of waves. Also referred to as *Burr Ball* or *Hair Ball*.

Lake Bonneville (Ice Age Lake) [Utah and Nevada] — A large, ancient *Ice Age Pluvial Lake* that existed from about 32,000 to 14,000 years before present (B.P.). Lake Bonneville occupied the lowest, closed depression in the eastern *Great Basin* and at its largest extent covered nearly 20,000 square miles of western Utah and smaller portions of eastern Nevada and southern Idaho. By comparison, *Lake Lahontan*, another pluvial Great Basin lake which also existed at this time of the late *Pleistocene Epoch*, covered approximately 8,600 square miles in northwestern Nevada. At its largest, Lake Bonneville was about 325 miles long, 135 miles wide, and had a maximum depth of over 1,000 feet. It contained many islands that are the present-day mountain ranges of western Utah. Its relatively fresh water was derived from direct precipitation, rivers, streams, and water from melting glaciers. During the time of Lake Bonneville, the climate was somewhat wetter and colder than now. Three major shorelines were left by Lake Bonneville, and one by the Great Salt Lake.

Shoreline Name (Terraces)	Elevation[3] at Antelope Island (Feet MSL)	Approximate Age in Calendar Years Before Present (B.P.)
Gilbert[1]	4,275 feet	12,800 - 11,600 B.P.
Provo[2]	4,840	16,800 - 16,200
Bonneville[2]	5,220	18,000 - 16,800
Stansbury[2]	4,445	24,400 - 23,200
[1] Great Salt Lake shoreline; [2] Lake Bonneville shoreline; [3] Feet above mean sea level (MSL).		

The Provo and Bonneville shorelines of Lake Bonneville can be seen as terraces or benches along many mountains in western Utah. The Stansbury shoreline of Lake Bonneville and the Gilbert shoreline of the Great Salt Lake are less obvious, and are found lower in the valleys. Each shoreline represents an extended period during which the lake stood at that elevation. The four main terraces or shorelines, their elevations, and the ages of their formation are given above. Fish lived in Lake Bonneville while amphibians, waterfowl, and other birds inhabited its marshes; and animals such as buffalo, horses, bears, rodents, deer, camels, bighorn sheep, musk oxen, and woolly mammoths roamed its shores. The arrival of humans in the Lake Bonneville Basin has been set by archaeologists at about 10,000 years ago. For a long period of its history, Lake Bonneville was a terminal lake with no rivers draining from it. The lowest outlet for Lake Bonneville, Red Rock Pass in Idaho, had an elevation of about 5,090 feet.

Approximately 16,800 years ago, the lake rose to the elevation of Red Rock Pass and began to flow northward into the Snake (Columbia) River drainage. The flow of water through the pass began a rapid downcutting process that resulted in a catastrophic flood, which is believed by researchers to have lasted probably less than a year. During this year, however, floodwaters cut through the pass's soil and rocks and lowered the outlet's elevation by about 375 feet. At that point, the lake stabilized and the Provo shoreline formed over the next 600 years. After the Lake Bonneville flood, the Great Basin gradually became warmer and drier. Lake Bonneville began to shrink farther due to decreased precipitation and increased evaporation. Today's Great Salt Lake is a large remnant of Lake Bonneville, and occupies the lowest depression in the Great Basin. The size, shape, and location of this depression have been controlled by basin and range faulting. Subsidence within the depression, caused by downfaulting, has accommodated deposition of as much as 12,000 feet of sediment carried into the lake by its tributaries. It has also allowed the lake to remain in a relatively constant position. Other relics of Lake Bonneville are Utah Lake, Sevier Lake, and the Great Salt Lake Desert containing the famous Bonneville Salt Flats. Also see *Geologic Time*.

Lake Effect Snowstorm — A type of snowstorm produced when very cold air flows across relatively warm waters of lakes. These type of storms are common around the *Great Lakes* but can also occur elsewhere, e.g., the *Great Salt Lake*.

Lake Evaporation — Normal evaporation such as from a pond or lake.

Lake Lahontan (Ice Age Lake) [Nevada and California] — A *Pluvial Lake* that formed within the western portion of the *Great Basin*, occupying the majority of northwestern Nevada during much of the *Pleistocene Epoch* (2 million to 10,000 years before present, B.P.). Lake Lahontan was formed at a time when regional climatic conditions were much different than they are today. Precipitation in the Great Basin region was at a much higher level than it is today, and evaporation rates were very much decreased, allowing for the formation of a large inland body of water within the enclosed basin complex. Presently, Lake Lahontan exists only as several relatively small remnant lakes – primarily Pyramid Lake and Walker Lake – that have managed to survive due to perennial tributary streams. Lake Lahontan was the second largest pluvial lake in the northern hemisphere (after *Lake Bonneville*), covering approximately 8,600 square miles (22,000 square km) during its period of high water level (peaking highstand). The basin which encompassed Lake Lahontan covered the majority of the northwestern portion of the Great Basin, and extended between approximately 117E 30" and 119E 30" west longitude, and 38E 30" and 41E 30" north latitude. The drainage basin covered approximately 45,000 square miles (115,000 square km) and extended from the northwest corner of Nevada to the northeast portion of California, and north into Oregon. This Ice Age lake was fed by the flows of the Truckee, Carson, Walker, Humboldt, Susan and Quinn rivers, attained a maximum surface elevation of approximately 4,380 feet, reached a maximum depth of at least 886 feet where Pyramid Lake, the lowest point in the system, now remains, covered the Lahontan Valley Wetlands (Stillwater Wildlife Refuge) to a depth of 500–700 feet, stretched from just below Nevada's northern boundary to Walker Lake, and extended well up the lower Truckee Canyon towards the city of Reno to near the present-day location of Lagomarsino Canyon near Lockwood. Lake Lahontan experienced at several peaking enlargements – approximately 65,000, 45,000, 30,000, and as recently as 12,500 years ago – and at times nearly dried up. Lake Lahontan's history began approximately 12 to 15 million years before present (B.P.) with the final stages of the Great Basin's formation. During this period, the upper plates began a series of faults that were upward steepening and that surfaced as normal faults. This period of detachment faulting continued on into the early Pliocene Epoch (approximately 5 million years B.P.) causing the Great Basin to expand by almost 50 percent. It wasn't until the late Pliocene to early Pleistocene that the western edge of the basin was completely enclosed by the Sierra Nevada Range. Previous to this time period, water could flow out of the Great Basin through channels in the young Sierra Nevada. During the late Pliocene and early Pleistocene, however, the Sierra Nevada was tilted westward by a series of heavy uplift, thereby completely enclosing basin with very few inflows or outflows. The Lahontan basin area, in which Lake Lahontan was formed, isn't completely cut off from outside precipitation systems since precipitation from the west does make its way over the Sierra Nevada from time to time. However, these small amounts of precipitation have an overall very miniscule effect on the inner workings of the system itself. Lake Lahontan formed during a time period of heightened precipitation and decreased *Evapotranspiration*. Precipitation in the Lake Lahontan region today is thought to be about one tenth of what it was during the Pleistocene, and evapotranspiration is now much greater, therefore creating an inverse relationship between the two time periods. Presently, the most notable part of the Lake Lahontan basin is the ancient shoreline formations, which may be traced out on many of the mountain sides throughout the basin. Lake Lahontan's immense size allowed it to produce shoreline formations that rival the magnitude of coastal-marine formations which are found only in a select few places around the world, almost always formed by large pluvial paleolakes. Also see *Geologic Time*.

Lake Levels and Salinity (Geoindicator) [GCRIO] — The history of fluctuations in lake levels provides a detailed record of climate changes on a scale of ten to a million years. Lakes can also be valuable indicators of near-surface groundwater conditions. Lakes are dynamic systems that are sensitive to local climate and to land-use changes in the surrounding landscape. Some lakes receive their water mainly from precipitation, some are dominated by drainage runoff, and others are controlled by groundwater systems. On a time scale ranging from days to millennia, the areal extent and depth of water in lakes are indicators of changes in climatic parameters such as precipitation, radiation, temperature and wind speed. Lake level fluctuations vary with the water balance of the lake and its catchment, and may, in certain cases, reflect changes in shallow groundwater resources. Especially useful as climatic indicators are lakes without outlets (endorheic or terminus), which widely distributed in North America, Africa, Central Asia, the Middle East, and Australia. In arid and semi-arid areas, the levels and areas of lakes with outflows are also highly sensitive to weather. Where not directly affected by human actions, lake level fluctuations are excellent indicators of drought conditions. For example, lake levels throughout the southern prairie provinces of Canada dropped in response to the warm, dry weather of the 1980s. Ephemeral or seasonally-flooded lake basins (playas) are dynamic landforms, the physical character and chemical properties of which reflect local hydrologic changes, and which react sensitively to short-term climate changes (e.g. rate of evaporation). Fluctuations in lake water salinity (e.g. CaHCO_3 , MgHCO_3 , CO_3 , MgSO_4 , NaSO_4) also provide an indication of changes in conditions at the surface (climate, inflow/outflow relations) and in shallow groundwater.

See *Geoindicators* [U.S. Global Change Research Information Office].

Lake Plain — (Geology) (1) A nearly flat surface that marks the floor of a former lake that was filled in as sediments were deposited by inflowing streams. (2) Such a lake bed that borders an existing lake. (3) A major landform of some *Bolson* floors that is built of the nearly level, fine textured, stratified, bottom sediments of a *Pleistocene Epoch* lake.

Lake-Plain Terrace — A somewhat elevated portion and component landform of a *Lake Plain*.

Lake Tahoe [California and Nevada] — A high altitude alpine lake located in the Sierra Nevada along the California-Nevada border at an elevation of 6,223 feet (its natural rim) above mean sea level (MSL). Lake Tahoe is 22 miles long and between 8 and 13 miles wide, and has a shoreline of some 75 miles. In terms of ranking, Lake Tahoe is the third deepest lake in North America and the tenth deepest lake in the world. Lake Tahoe's surface area covers 194 square miles (124,160 acres) and its depth has been recorded at approximately 1,640 feet MSL (based on a "normal" lake surface level of 6,228 feet MSL), giving it a total estimated volume of approximately 122 million acre-feet. This is enough water to cover the entire surface area of the State of California (104,772,550 acres) to a depth of approximately 14 inches (1.16 feet) and the State of Nevada (70,745,600 acres) to a depth of nearly 21 inches (1.72 feet). Lake Tahoe's surface water temperatures vary from a winter minimum of 40-45 degrees Fahrenheit to a summer maximum of 65-75 degrees Fahrenheit. At depths below 500 feet, the waters of Lake Tahoe remain a constant 39 degrees Fahrenheit. The lake lies on the border between California and Nevada at 120 degrees west longitude. This north-south state border runs through a line just to the east of the approximate centerline of Lake Tahoe, turning in a southeasterly direction at 39 degrees north latitude, thereby placing approximately two-thirds of Lake Tahoe within the State of California and one-third within the State of Nevada. The lake was formed along an ancient fault line which later filled with water during the *Pleistocene*, or glacial epoch some 2 million to 500,000 years ago. Scientific examination of the lake's bottom has found that lakebed sediments extend at least 2,600 feet below the present lakebed. The maximum prehistoric depth has been reported to have been up to 7,000 feet deep. Lake Tahoe is directly fed by 63 creeks and streams which drain the 506 square mile Lake Tahoe Basin. The principal tributaries of Lake Tahoe include the Upper Truckee River, which drains an area extending for 15 miles due south of Lake Tahoe, Trout and Taylor creeks, also located at the south end of Lake Tahoe, and Ward and Blackwood creeks. Together, these five tributary streams carry more than one half (averaging some 166,290 acre-feet per year) of Lake Tahoe's average surface water inflows of 310,000 acre-feet per year. The Lake Tahoe Basin annually produces approximately 530,000 acre-feet of water inflows into Lake Tahoe from all sources (surface and groundwater inflows and lake surface precipitation). Of these total inflows into the lake, approximately 350,000 acre-feet (about 34 inches per year), or 66 percent of total inflows, are lost to evaporation. The Lake Tahoe Basin also includes a number of other lakes, including Fallen Leaf Lake (1,400 acres), Marlette Lake (381 acres), Upper and Lower Echo Lakes (330 acres), Cascade Lake (210 acres), and Spooner Lake (97 acres). Numerous other small lakes and ponds comprise an additional 600 acres of surface water within the Lake Tahoe Basin. Lake Tahoe has a single outlet consisting of the Truckee River, which flows out of the lake at Tahoe City, located on the northwestern shore of the lake in Placer County, California. From this outlet to Lake Tahoe, the Truckee River travels a total distance of approximately 50 air miles and 105 river miles to its terminus, *Pyramid Lake*, located in the desert of western Nevada. Within California, Lake Tahoe is bordered (from south to north) by the counties of El Dorado and Placer. Within Nevada, Lake Tahoe is bordered by the counties of Douglas, Carson City, and Washoe. The first dam at Lake Tahoe's exit into the Truckee River was constructed in the early 1870's, while the existing Lake Tahoe Dam, consisting of 17 controllable gates, was constructed in 1913. Lake Tahoe is both a natural lake and a controlled reservoir. Water is stored only in the top 6.1 feet of Lake Tahoe, from a surface elevation of 6,223.0 feet MSL, established by the 1935 *Truckee River Agreement* to be the lake's natural rim, to an upper legal storage elevation of 6,229.1 feet MSL. Total storage capacity within this upper controllable 6.1 feet equals approximately 744,600 acre-feet and is used to supplement the Truckee River's *Floriston Rates* (minimum required rates of flow) in conjunction with natural runoff of other tributaries and Boca Dam (Little Truckee River) releases. Water releases from Lake Tahoe are controlled by a federal water master. The Lake Tahoe Dam is owned by the U.S. Bureau of Reclamation (USBR) and operated under agreement by the *Truckee-Carson Irrigation District (TCID)* for the *Newlands Irrigation Project* located in Churchill County, Nevada. Lake Tahoe's storage capacity is not considered part of the U.S. Army Corps of Engineers (COE) flood control system. Lake Tahoe waters may be exchanged for water from Prosser Creek Reservoir (*Tahoe-Prosser Exchange Agreement*) in order to maintain a live stream below the Lake Tahoe Dam without adversely affecting Nevada water users' storage rights. Whenever possible, Lake Tahoe releases must be sufficient to maintain a minimum instream flow of 50-70 cubic feet per second (cfs) downstream from the dam (varies with season). Lake Tahoe is known for its extremely blue waters and remarkable clarity, characteristics which more recently have been threatened by extensive development within the basin, shoreline erosion, and surface water runoff, which have added nutrients to the lake, thereby increasing algae growth. The *Tahoe Region Planning Agency (TRPA)*, a federal and bi-state (California and Nevada) agency, is responsible for monitoring and controlling growth, land use, and development within the Lake Tahoe Basin.

Lake Terraces — See *Wave-Cut Terraces*.

Lake Truckee [California] — In Neocene times, which occurred during the late Tertiary Period approximately 25 million to 13 million years ago and encompassed both the Pliocene and Miocene Epochs, Lake Truckee was formed from a basalt flow that dammed the upper Truckee River canyon just below the present-day site of Hirshdale, California. The lake covered an area of some 73 square miles, its surface level reached an elevation of at least 6,000 feet above mean sea level (MSL), and attained a maximum depth of 465 feet. Lake Truckee remained through part of the glacial (Pleistocene) period until the river eventually wore down the obstruction and subsequently drained the lake.

Lakes, Seepage — Lakes whose ecology is determined primarily by groundwater rather than surface water.

Lake Whitening — A phenomenon which occurs in moderately productive lakes when photosynthetic uptake of carbon dioxide (CO₂) causes the precipitation of small particles of calcite (mostly calcium carbonate, CaCO₃). Since small particles have a greater effect on water transparency and typical calcite particles are only 1-2 micrometers (µm) in diameter, lake water takes

on a milky appearance, hence lending to its name.

Lambert-Beer Equation — See *Light-Attenuation Coefficient*.

Laminar Flow — A flow in which fluid moves smoothly in streamlines in parallel layers or sheets. The stream lines remain distinct and the flow directions at every point remain unchanged with time. It is characteristic of the movement of groundwater. Contrasts with turbulent flow. Synonymous with *Streamline Flow* and *Viscous Flow*.

Land — The entire complex of surface and near surface attributes of the solid portions of the surface of the earth, which are significant to man. Water bodies occurring within land masses are included in some land classification systems.

Land Application — The reuse of reclaimed water or the utilization or disposal of effluents on, above, or into the surface of the ground through spray fields or other methods.

Land Breeze — The land-to-sea surface wind that occurs in coastal areas at night. It is caused by the rising of the air above the ocean, which is warmer than the land due to the rapid cooling of the land after sunset. Contrast with *Sea Breeze*.

Land Capability — The suitability of land for use without permanent damage. Land capability, as ordinarily used in the United States, is an expression of the effect of physical land conditions, including climate, on the total suitability for use, without damage, for crops that require regular tillage, for grazing, for woodland, and for wildlife. Land capability involves consideration of the risks of land damage from erosion and other causes and the difficulties in land use owing to physical land characteristics including climate.

Land Capability Classification — The U.S. Department of Agriculture (USDA), *Natural Resources Conservation Service (NRCS)*, formerly the *Soil Conservation Service (SCS)*, has distinguished eight classes of land capability according to the risk of land damage or the difficulty of land use:

- [1] **Class I** — Soils that have few limitations restricting their use;
- [2] **Class II** — Soils that have some limitations, reducing the choice of plants or requiring moderate conservation practices;
- [3] **Class III** — Soils that have severe limitations that reduce the choice of plants or require special conservation practices, or both;
- [4] **Class IV** — Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both;

The following classes are generally not considered suitable for cultivation without some form of major treatment:

- [5] **Class V** — Soils that have little or no erosion hazard, but that have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover;
- [6] **Class VI** — Soils that have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover;
- [7] **Class VII** — Soils that have very severe limitations that make them unsuited to cultivation and that restricts their use largely to grazing, woodland, or wildlife;
- [8] **Class VIII** — Soils and land forms that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or aesthetic purposes.

Land Development (for Irrigation) — The following constitutes a partial listing of land development and improvement activities normally associated with irrigation projects. While these techniques have been prevalent in the past and have had a beneficial effect on land from an agricultural productivity standpoint, more recent concerns over wetland preservation and restoration and wildlife habitat concerns have tended to more recently restrict their widespread usage.

- [1] **Land Leveling and Smoothing** — Leveling to a more uniform grade to permit more efficient gravity irrigation and to facilitate surface drainage on undulating lands developed for sprinkler or drip irrigation;
- [2] **Artificial Drainage** — Installation of tile drains or ditches or installation of drainage wells to facilitate the removal of excess water from lands prone to accumulate excess water;
- [3] **Deep Ripping** — When some lands, especially older terrace deposits, develop hardpan or cemented layers, if relatively thin in nature, they can often be ripped by powerful equipment thereby deepening the effective root zone and improving internal soil drainage;
- [4] **Soil Amendments** — In order to improve the chemical and physical properties of the soil, it is sometimes necessary to apply gypsum, sulfur, or farm manure to the land;
- [5] **Terracing** — A technique specifically designed for sloping land to prevent accelerated erosion on exposed slopes;
- [6] **Land Clearing** — Initially and periodically, brush and trees must be cleared from irrigated lands to improve overall productivity;
- [7] **Surface Outlet Excavation** — A technique to provide an outlet for standing water, most common in prior glacial areas where many closed depressions allow for the accumulation of runoff during wet periods;
- [8] **Tailwater Return Systems** — Allow for the recycling and reuse of farm runoff water for additional irrigation;
- [9] **Rock Removal** — Particularly prevalent in glacial areas, initial and periodic surface rock is especially important for development and on-going use of irrigated lands;
- [10] **Shelter Belt Planting** — Mitigates wind erosion and provides cover for livestock and wildlife by planting tree lines in strategically located areas in and around irrigated fields.

Land Farming — A technique for the controlled biodegradation of organic waste that involves the mixture of waste sludges with soil. Microorganisms in the soil degrade the organic wastes. The biodegradation is enhanced by tilling the soil-waste mixture to ensure adequate oxygen and the control of moisture content, nutrient levels, and soil pH.

Land Improvement — See *Land Development*.

Land Pan — An evaporation pan located on land. See *Evaporation Pan*.

Land Reclamation — Making land capable of more intensive use by changing its general character, as by drainage of excessively wet land, irrigation of arid or semiarid land, or recovery of submerged land from seas, lakes, and rivers.

Land Reconstruction — (Mining) (1) Restoring land and water areas adversely affected by past mining practices and increasing the productivity of the areas for a beneficial use. (2) Restoring currently mined land to an acceptable form and for a planned use.

Land Retirement — (Agriculture) Taking land out of agriculture production by leaving it fallow or letting it return to a natural state.

Land Spreading — The disposal of solid effluents derived from wastewater treatment facilities on the surface of the ground for dilution or dispersal.

Land Subsidence — The sinking or settling of land to a lower level in response to various natural and man-caused factors, for example:

- [1] earth movements;
- [2] lowering of fluid pressure (or lowering of groundwater level);
- [3] removal of underlying supporting materials by mining or solution of solids, either artificially or from natural causes;
- [4] compaction caused by wetting (*Hydrocompaction*);
- [5] oxidation of organic matter in soils; or
- [6] added load on the land surface.

With respect to groundwater, subsidence most frequently results from overdrafts of the underlying water table or aquifer and its inability to fully recharge, a process termed *Aquifer Compaction*. Also see *Subsidence*.

Land Surface Datum (Isd) — A datum plane that is approximately at land surface at each groundwater observation well.

Land Treatment Measures — The application of vegetative tillage, structural and land management measures, individually or in combination, to alter runoff, to reduce erosion and sediment production, to increase fertility, and to improve drainage and irrigation applications. Also refers to the land disposal of sludge from sewage treatment plants.

Land Use — The primary or primary and secondary uses of land, such as cropland, woodland, pastureland, etc. The description of a particular land use should convey the dominant character of a geographic area, and thereby establish the types of activities which are most appropriate and compatible with primary uses.

Land Use Plan — A coordinated composite of information, ideas, policies, programs, and activities related to existing and potential uses of land within a given area and frequently the key element in a comprehensive plan for an area under development for public and private land uses, such as residential, commercial, industrial, recreational, and agricultural activities.

Land Use Planning — The process of inventorying and assessing the status, potentials, and limitations of a particular geographic area and its resources, interacting with the populations associated and/or concerned with the area to determine their needs, wants, and aspirations for the future.

Land Voiding — The process of damaging land by gully action causing this land to be unproductive for agricultural uses and relegating its use primarily to wildlife and recreation.

Landfill — (1) A method of disposing of refuse on land by utilizing the principles of engineering to confine the refuse to the smallest practical area and to reduce it to the smallest practical volume. (2) (Environmental) Facility in which solid waste from municipal and/or industrial sources is disposed; sanitary landfills are those that are operated in accordance with environmental protection standards. (3) (Water Quality) A disposal site which disposes of solid wastes on land. Wastes are deposited and compacted. At specific intervals, a layer of soil covers the waste and the process of deposit and compaction is repeated. The purpose is to confine the wastes to the smallest practical area and volume without creating nuisances or hazards to public health and safety, for example through leaching into the groundwater below the waste site.

Landform — (Geography) (1) A discernible natural landscape that exists as a result of wind, water or geological activity, such as a plateau, plain, basin, mountain, etc. (2) A three dimensional part of the land surface, formed of soil, sediment, or rock that is distinctive because of its shape, that is significant for land use or to landscape genesis, that repeats in various landscapes, and that also has a fairly consistent position relative to surrounding landforms.

Landform Element — A morphological part of a component landform. Sideslope landform elements may be divided into slope components.

Landlocked — (1) Enclosed or nearly enclosed by land, as a landlocked country without access to the sea or ocean. (2) Confined to fresh water by some barrier, as salmon.

Lands — References to federally owned lands are defined as follows:

- [1] **Federal** — All classes of land owned by the federal government, which includes *Public Domain (Lands)*, withdrawn and acquired federal lands;
- [2] **Acquired** — Lands acquired by the federal government through purchase, condemnation, or gift;
- [3] **Withdrawn** — Federal lands for which formal withdrawal action has been taken which restricts the disposition of specific public lands and which holds them for specific public purposes; also, public lands which have been dedicated to public purposes;
- [4] **National Forest** — Federal lands which have been designated by executive order or statute as national forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands; and
- [5] **Public Domain** — Original public lands which have never left federal ownership. Also includes lands in federal ownership which were obtained by the federal government in exchange for public lands, or for timber on public lands.

Also see *Public Domain (Lands)*.

Landscape — (1) (Geography) All the natural features, such as fields, hills, forests, and water that distinguish one part of the earth's surface from another part. Usually refers to that portion of land or territory which the eye can comprehend in a single view, including all of its natural characteristics. These characteristics are a result not only of natural forces but of human occupancy and use of the land as well. (2) (Ecology) A heterogeneous area composed of a cluster of interacting *Ecosystems* that are repeated in similar form throughout the area. Forest landscapes of the Southwest United States usually range from hundreds to thousands of acres and are the result of geologic, edaphic (soil), climatic, biotic, and human influences.

Landscape Impoundment — A body of reclaimed water which is used for aesthetic enjoyment or which otherwise serves a function not intended to include contact recreation.

Landslide — A mass of material that has slipped downhill under the influence of gravity, frequently occurring when the material is saturated with water.

Landtype — A land system with a designated soil, vegetation, geology, topography, climate, and drainage situation.

Langelier Index (LI/L.I.) — (1) An expression of the ability of water to dissolve or deposit calcium carbonate scale in pipes. The index has important implications in industrial water system where the formation of scale or sludge can cause equipment or process failure. The index is calculated from direct measurements of the following in the water system: pH, alkalinity, calcium concentrations, total dissolved solids, and temperature. A positive value indicates a tendency to form scale, and a negative value means the water will dissolve scale and may be corrosive. (2) An index reflecting the equilibrium pH of a water with respect to calcium and alkalinity. This index is used in stabilizing water to control both corrosion and the deposition of scale. The Langelier index is equivalent to:

$$L.I. = (pH - pH_s)$$

where:

pH = actual pH of the water, and

pH_s = pH at which the water having the same alkalinity and calcium content is just saturated with calcium carbonate.

Lap — (1) To wash or slap against with soft liquid sounds, as waves on a seashore. (2) A watery food or drink.

Lapse Rate — The rate of change of temperature with height in the free atmosphere.

Large Capacity Well — A well capable of delivering water in excess of four one-hundredths cubic feet per second or eighteen gallons per minute.

Large Water System — A water system that services more than 50,000 customers.

“Lasagna” Process — (Environmental) A cleanup technique involving the use of an electrical current to treat subsurface hazardous waste. The process, which derived its name from the layered structure of various treatment zones in the soil, grew from a cooperative initiative launched by the *U.S. Environmental Protection Agency (EPA)* in 1992 to develop innovative techniques to treat buried hazardous waste *in situ*, thereby requiring no excavation. See *Phytoremediation*.

Laser Land Leveling — The use of precision instruments featuring laser beams to guide earth-moving equipment for leveling land for surface-type irrigation in order to improve irrigation efficiency. See *Laser Leveling*.

Laser Leveling — Laser leveling allows topographic profiles of an area to be mapped quickly and accurately with a laser. A base unit transmits a laser beam in a 360 degree circle from the base to a range of about 1,500 meters (nearly 5,000 feet). A large pole with measurement markings on it is used in correlation with a receiver that slides on the pole. The receiver is slid up or down the pole until it locks directly onto the laser beam and emits a constant beep. The height is then measured off of the pole based on the position of the receiver. Laser leveling is used extensively in construction and the preparation of agricultural fields for flood irrigation, thereby precluding *Ponding* or erosion from rapid runoff. Also see *Laser Land Leveling*.

Late Seral Condition — Synonymous with good ecological conditions.

Latency — Time from the first exposure to a chemical until the appearance of a toxic effect.

Latent Heat — (1) The quantity of heat absorbed or released by a substance undergoing a change of state, such as ice changing to water or water to steam, at constant temperature and pressure. (2) The heat released or absorbed per unit mass of water in a reversible, isobaric-isothermal change of phase. Also referred to as the *Heat of Transformation*.

Latent Heat of Condensation — The amount of heat released by a unit mass of substance, without change in temperature, while passing from the vapor to the liquid state.

Latent Heat of Vaporization — The amount of heat absorbed by a unit mass of substance, without change in temperature, while passing from the liquid to the vapor state.

Latent Heat Transfer — The removal or addition of heat when a substance changes state. In the environment, this almost always refers to the release of heat from water upon condensation and the absorption of heat by water upon evaporation. Also see *Latent Heat of Condensation* and *Latent Heat of Vaporization*.

Lateral — (1) A branch canal or pipeline that diverges from the main canal or other branches. (2) (Irrigation) A water project or irrigation conveyance structure, smaller than a canal intended to convey water away from the main canal or ditch. The part of an irrigation district's delivery system that conveys water from the district's main canals to turnouts for farmers's fields. (3) (Water Quality) A municipal wastewater drain pipe that connects a home or business to a branch or main line.

Lateral Accretion Deposits — In valley sediment deposition, lateral accretion deposits consist of point and marginal bars that may be preserved by channel shifting and added to the overbank floodplain by vertical accretion deposits at the top. See *Valley Sediment Deposits*.

Lateral Erosion — (Geology) The wearing away of the banks of a meandering stream in a horizontal direction as the stream swings

from side to side and undercuts its banks.

Lateral Line — A series of sensory pores along the head and sides of fish and some amphibians by which water currents, vibrations, and pressure changes are detected.

Lateral Moraine — (Geology) (1) A ridge-like accumulation of fallen rock fragments transported on or deposited at or near the side margins of a *Glacier*, or along the side of a valley occupied by a glacier. Also referred to as a *Side Moraine* or *Valley-Side Moraine*. (2) The ridges of *Glacial Till* that mark the sides of a glacier's path. Also see *Moraine*, *Terminal Moraine*, and *Recessional Moraine*.

Lateral Planation — (Geology) The leveling of the land adjacent to a stream or a flood plain as a result of the lateral erosion of a stream against its banks.

Lateral Sewers — Pipes that run under city streets and receive the sewage from homes and businesses, as opposed to domestic feeders and main trunk lines.

Lateral Storage — See *Bank Storage*.

Lateritic Soil — Land that consist of minerals that are rich in iron and aluminum compounds, other minerals having been removed by *Leaching*. The land is hard and unsuitable for agricultural use.

Lattice Drainage Pattern — See *Rectangular Drainage Pattern*.

Launch — (Nautical) To put (a boat) into the water in readiness for use.

Laundering Weir — (1) A sedimentation basin overflow weir. (2) An overflow weir consisting of a plate with V-notches along the top to assure a uniform flow rate and avoid short-circuiting.

Launders — Sedimentation basin and filter discharge channels, consisting of overflow weir plates (in sedimentation basins) and conveying troughs.

Lava Flow — (Geology) A solidified mass of rock formed when a stream of viscous, molten lave from a volcano or fissure has cooled and congealed.

Lavage — A washing, especially of a hollow organ, such as the stomach or lower bowel, with repeated injections of water.

Lavatory — (1) A room equipped with washing and often toilet facilities; a bathroom. (2) A washbowl or basin, especially one permanently installed with running water. (3) A flush toilet.

Lave — (1) to wash or bathe. (2) to flow along or against. (3) to dip or pour with or as with a ladle.

Law (or Rule) of Constant Proportions — See *Principle of Constant Proportions*.

“Law of the River” [Colorado River] — Refers to a collection of compacts, agreements, contracts, an international treaty with Mexico, state and federal legislation, U.S. Supreme Court decisions, and federal administrative actions which, taken together, apportion the water and regulate the use and management of the Colorado River moving through seven southwestern states – Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming – and Mexico. The most significant of these many documents include the following:

- [1] The *Colorado River Compact* of 1922 which divided the rights to use the water between the upper and lower basis separated at Lees Ferry near the Utah-Arizona border along the Colorado River;
- [2] The Boulder Canyon Project Act of 1928 which authorized construction of Boulder Dam (later renamed Hoover Dam) and power plant, Lake Mead, an the All-American Canal taking water to the Imperial and Coachella valleys in southern California;
- [3] The Mexican Water Treaty of 1944 in which the United States agreed to deliver 1.5 million acre-feet of Colorado River water to Mexico annually, except under surplus or shortage conditions;
- [4] The Upper Colorado River Basin Compact of 1948 which apportioned the use of water among the upper basin states of Colorado, Wyoming, Utah, New Mexico, and Arizona;
- [5] The Colorado River Storage Project Act of 1956 which authorized several storage reservoirs and dams in the upper basin and on tributary rivers;
- [6] The 1963 *Arizona v. California* U.S. Supreme Court decision which resolved the lower basin apportionment among Arizona, California, and Nevada;
- [7] The Colorado River Basin Project Act of 1968 which authorized the Central Arizona Project (CAP) an limited diversions to CAP during shortages to assure California's use of its annual 4.4 million acre-feet apportionment;
- [8] The “Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs of 1970” which provided for the coordinated operation of reservoirs in the upper and lower basins and set conditions for water releases from Lake Powell (Glen Canyon Dam) and Lake Mead (Hoover Dam);
- [9] Code of Federal Regulations (CFR), Title 43, Part 417, 1972, which requires that the use of Colorado River water in the lower basin by an entitlement holder must not exceed the amount reasonably required for the beneficial uses authorized by the entitlement;
- [10] Minute 242 of the International Boundary and Water Commission, United States and Mexico, issued in 1973, which required actions to reduce the salinity of water arriving at Morelos Dam, which was to be delivered to Mexico;
- [11] The Colorado River Basin Salinity Control Act of 1974 and its 1984 amendments which authorized desalting and salinity control projects to improve Colorado River water quality; and
- [12] The various requirements contained in the federal *Endangered Species Act (ESA)*, Grand Canyon Protection Act of 1992, and American Indian water claim settlements which together affect the extent to which further affect water developments and diversions in the Colorado River Basin.

Layer Depth — (Oceanography) The thickness of the mixed layer; the distance from the water's surface to the top of the main *Thermocline*.

Layer of No Motion — (Oceanography) A layer of water assumed to be at rest at some depth.

LC₅₀ (Lethal Concentration–50) — (1) The concentration of a toxic substance which is fatal to 50 percent of the organisms tested under specific test conditions and time periods. (2) The concentration of a chemical in air or water which is expected to cause death in 50 percent of test animals living in that air or water.

LCCA — Lead Contamination Control Act.

LD₅₀ (Lethal Dose–50) — (1) The dose of a toxicant that is fatal to 50 percent of the organisms tested in a specific time. The dose is the actual quantity administered to the organism. (2) The dose of a chemical taken by mouth, injected, or absorbed by the skin which is expected to cause death in 50 percent of the test animals so treated.

Le Châtelier's Principle — A principle of dynamic equilibrium stating that a change in one or more factors that maintain equilibrium conditions in a system will cause the system to shift in a direction that will work against or adjust to the change(s), with a resulting reestablishment of equilibrium conditions. For example, assume the concentrations of gaseous oxygen in the atmosphere and dissolved oxygen in a stream are in equilibrium at a certain temperature. As oxygen dissolves in water, heat is released. If an outside influence (e.g., sunlight) raises the water temperature in the stream, this shifts the equilibrium back in the direction of lower dissolved oxygen and greater atmospheric oxygen, and oxygen escapes from the water. As a result, at higher water temperatures, equilibrium concentrations of dissolved oxygen are lower.

Leach — (1) To apply water in excess of a crop's needs to flush out salts from the root zone. (2) To remove soluble or other constituents from a medium by the action of a percolating liquid, as in leaching salts from the soil by the application of water.

Leachate — Liquid which has percolated through the ground, such as water seeping through a sanitary landfill, wastes, pesticides, or fertilizers. The liquid that has percolated through solid waste and dissolved soluble components. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, groundwater, or soil.

Leachate Collection System — An arrangement of reservoirs and pipes underlying a waste disposal site designed to accumulate and remove *Leachate*, water that migrates through the waste, and pump it to the surface for treatment.

Leached Layer (Soil) — A soil layer or an entire soil profile from which the soluble materials (CaCO₃ and MgCO₃ and material more soluble) have been dissolved and washed away by percolating waters.

Leaching — (1) The washing out or flushing of a soluble substance from an insoluble one. (2) The flushing of salts from the soil by the downward percolation of applied water. The process of removing water-soluble material from the soil by passing water through it. (3) The process by which soluble substances are dissolved and transported down through the soil by recharge. (4) The process by which soluble materials in the soil, such as salts, nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water. Also see *Leachate*.

Leaching Efficiency — The ratio of the average salt concentration in drainage water to an average salt concentration in the soil water of the root zone when near field capacity (also defined as the hypothetical fraction of the soil solution that has been displaced by a unit of drainage water).

Leaching Field — The area used for disposal of liquid through a non-water-tight artificial structure, conduit, or porous material by downward or lateral drainage, or both, into the surrounding permeable soil.

Leaching, Heap — See *Heap Leaching (Mining)*.

Leaching Requirement — (1) The amount of excess irrigation water passing through the *Root Zone* to reduce the salt concentration in the soil for reclamation purposes. (2) The theoretical amount of irrigation water that must pass (leach) through the soil beyond the root zone to keep soil salinity within acceptable levels for sustained crop growth. (3) That fraction of irrigation water (*Crop Water Requirement*) that must be leached through the root zone to control soil salinity at a specified level. The extra water is used to dissolve the salts and move them from the soil root zone and out into a drainage tile or channel where they can be removed from the area entirely. Extra water can be added by irrigating more or by natural precipitation. The amount of water needed is governed by the amount of salt that the crop can tolerate in its root zone. As a general equation, this amount of water can be defined (U.S. Bureau of Reclamation, 1993) as a leaching requirement (LR):

$$LR = EC_{iw}/EC_{dw} \times 100$$

where:

LR = leaching requirement in percent;

EC_{iw} = electrical conductivity of irrigation water in millimhos per centimeter (mmhos/cm);

EC_{dw} = electrical conductivity of soil drainage water at the bottom of the root zone (mmhos/cm).

Both natural precipitation (rainfall) and conservation efforts affect the leaching requirement. Rainfall that enters the soil in sufficient quantity to create deep percolation will help move the salts down through the soil. As irrigators increase conservation efforts and use less water, there will be a point at which the deep percolation requirements for soil salt balance will not be met, soil salinity will increase, and crop production will decrease.

Lead — (1) To serve as a channel for a pipe as to conduct water to the house. (2) A channel of water, especially through a field of ice.

Lead (Pb) — Chemical symbol Pb. (1) A heavy metal that is hazardous to health if breathed or swallowed. Its use in gasoline, paints, and plumbing compounds has been sharply restricted or eliminated by federal laws and regulations. See *Heavy Metals*. (2) Lead is a toxic metal present in air, food, water, soil, and old paint. Overexposure to this metal can cause damage to circulatory, digestive, and central nervous systems. Children less than six years old are considered the most susceptible. Atmospheric levels have dropped sharply with the introduction of unleaded gasolines. Lead in air, water, and food is regulated by a number of environmental statutes to include the *Clean Air Act*, *Clean Water Act (CWA)*, *Safe Drinking Water Act (SDWA)*,

Food, Drug, and Cosmetic Act, among others.

Lead and Copper Rule [EPA] — Water quality standards covered under the *Safe Drinking Water Act (SDWA)*, and amendments thereto, as set by the *U.S. Environmental Protection Agency (EPA)*. The rule is a set of treatment technique requirements which apply to all community and non-transient non-community water systems (see *Public Water Supply Systems*). Treatment techniques rather than *Minimum Contaminant Levels (MCLs)* were established for lead and copper because the occurrence of these contaminants in a drinking water supply is usually the result of corrosion in plumbing materials within both the household plumbing and the distribution system. The rule requires all systems which do not meet the specified lead and copper action levels at the tap to optimize corrosion control treatment in an effort to minimize the levels of these contaminants. The action level is 0.015 mg/l (milligrams per liter) for lead and 1.3 mg/l for copper measured at the 90th percentile. See *90th Percentile*.

Lead (Time) — (Statistics) The difference in time units of a series value and a subsequent series value. In time series analysis, the lead represents the time by which the change in an independent or predictor (*Exogenous*) variable precedes the strongest (most significant) change in a dependent or predicted (*Endogenous*) variable. Also see *Lag (Time)*.

Lead (Pb) Free — A maximum lead content of 0.2 percent for solder and flux, and 8.0 percent for pipes and fittings.

Lead Line — (Nautical) A line marked at intervals of fathoms and weighted at one end, used to determine the depth of water. Also referred to as a *Sounding Line*.

Lead (Pb) Service Line — A service line made of lead which connects the water to the building inlet and any lead fitting connected to it.

Lead Tetraethyl or Tertramethyl — A basic element which, when added to gasoline in the form of chemical compounds, provides the last few additional octane points to gasoline. Also known as lead alkyls.

Leadsman — A person who uses a sounding lead to determine depth of water.

Leaf Area Index — The area of one side of leaves per unit area of soil surface.

Leaf Drip — Water that is intercepted and rerouted to the ground via collection on and drop from leaf surfaces.

Leakage — (1) The flow of water from one *Hydrogeologic Unit* to another. This may be natural, as through a somewhat permeable confining layer, or *Anthropogenic*, as through an uncased well. It may also be the natural loss of water from artificial structures, as a result of *Hydrostatic Pressure*. (2) (Dams) The uncontrolled loss of water by flow through a hole or crack.

Leaky Aquifer — An artesian or water table aquifer that loses or gains water through adjacent semipermeable *Confining Units*.

Ledge — The exposed edge of a rock stratum that acts as a low natural dam or as a series of such dams in a river system or along a river's reach.

Lee — Located in or facing the path of an oncoming glacier. Used of a geologic formation.

Left Abutment — That part of the left-hand side of a valley side wall against which a dam is constructed. The left abutment is viewed by an observer looking downstream.

Left Bank — The left-hand bank of a stream viewed when the observer faces downstream.

Legionella — A genus of bacteria, some species of which have caused a type of pneumonia called *Legionnaires Disease*.

Lemna Gibba (Duckweed) — The genus and species name of a small, stemless, free-floating plant used in experiments to determine the toxicity of pollutants to aquatic plant life. Commonly called duckweed.

Lentic — (1) Characterizing aquatic communities found in standing water. Compare to *Lotic*. (2) (Ecology) Of or relating to freshwater habitats characterized by calm waters, such as lakes, ponds, swamps, or bogs. Also spelled *Lenitic*.

Lentic System — A non-flowing or standing body of fresh water, such as a lake or pond. Compare to a *Lotic System*.

Lentic Waters — Ponds or lakes (standing water).

Lenticles — Tiny pores, into which oxygen passes, on the roots or branches of trees. For example, both red and black mangrove trees have lenticles on some of their roots.

Lenticular Clouds — Lenticular clouds are characteristic of all mountain ranges and form in response to wind. When strong winds blow over the mountains and force moist air up to cooler elevations, the moisture condenses. As the winds blow back down the other side of the mountains, the moisture re-vaporizes. The lenticular cloud is the condensed (visible) moisture under the wind stream; it doesn't drift like other clouds do because it's "trapped" in a pocket of relatively calm air just below the wind stream and just above warmer air below. The notion that the clouds are stationary is an optical effect. A lenticular cloud actually is forming on one end (front edge) and vanishing on the other, giving the appearance that it is in a fixed position. Lenticular clouds assume distinct shapes, generally resembling a disc (hence giving rise to a common name of "pancake clouds" or in a flat elongated shape stretching parallel to the mountain range. Also see *Clouds* and *Sierra Wave [Sierra Nevada Mountains]*.

Lethe — A river in Hades whose waters cause drinkers to forget their past.

Levee — (1) A naturally occurring, broad, low ridge of sand and coarse silt deposited along the banks of a stream or river during flooding. Also referred to as a *Natural Levee*. (2) A ridge of sediment that borders one or both sides of a deep-sea channel or fan valley. (3) A natural or man-made earthen obstruction along the edge of a stream, lake, or river. Also, a long, low embankment usually built to restrain the flow of water out of a river bank and protect land from flooding. If built of concrete or masonry, the structure is usually referred to as a flood wall. The term *Dike* is commonly used to describe embankments that block an area on a reservoir rim that are lower than the top of the main dam. (4) (Agronomy) A low ridge or bank of earth used to control the flow of water during irrigation. (5) (FEMA) A man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control or divert the flow of water so as to provide protection from temporary flooding.

Levee (Natural) — Bank of sand and silt built by a river during floods, where the *Suspended Load* is deposited in greatest quantity close to the river. The process of developing natural levees tends to raise river banks above the level of the surrounding flood plains. A break in a natural levee is sometimes called a *Crevasse*.

Levee (Manmade) — An embankment, generally constructed on or parallel to the banks of a stream, lake or other body of water,

- for the purpose of protecting the land side from inundation by flood water or to confine the stream flow to its regular channel.
- Levee System** — A flood protection system which consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accord with sound engineering practices.
- Level Controls** — A float device (or pressure switch) which senses changes in a measured variable and opens or closes a switch in response to that change. In its simplest form, this control might be a floating ball connected mechanically to a switch or valve such as is used to stop water flow into a toilet when the tank is full.
- Level of Development** — In a planning study, the practice of holding constant the population, irrigated acreage, industry, and wildlife so that hydrologic variability can be studied to determine adequacy of supplies.
- Level of Protection** — (FEMA) The greatest flood level against which a protective measure is designed to be fully effective; often expressed as a recurrence interval (e.g., 100-year level of protection) or as an exceedance frequency (e.g., one-percent chance of exceedance).
- Levigate** — (1) To make into a smooth, fine powder or paste, as by grinding when moist; to separate fine particles from coarse by grinding in water. (2) To suspend in a liquid.
- License** — An official document giving permission to engage in a specified activity, such as an appropriation of water.
- Lichen** — Any compound, thallophytic plant of the group *Lichenes* that is composed of a fungus in symbiotic union with an alga and has a greenish, gray, yellow, brown or blackish thallus growing in leaflike, crustlike or branching forms on rocks, trees, etc.
- Life Cycle** — The continuous sequence of changes undergone by an organism from one primary form to the development of the same form again.
- Life Cycle Assessment (LCA)** — (Environmental) An objective process to evaluate all the environmental burdens of a product or process through its entire existence (life cycle). This encompasses extracting and processing raw materials, manufacturing, transportation, distribution, use and maintenance, recycling and final disposal.
- Life Strategy Diversity** — (Biodiversity Measure) Diversity (richness and evenness) of species employing each resource use strategy (food resources used (insectivorous, granivorous, omnivorous, saprophytic, herbivorous, carnivorous) breeding strategy, general habitat associations). This measure provides another index of the diversity of processes.
- Life Zone** — (Ecology) A broad class of vegetation and climatic condition based on temperature and precipitation. Merriam's (1898) life zones in the Southwest United States include the Hudsonian, Canadian, and Transitional (from cool wet to warm dry; terms are nominal rather than specifically geographic).
- Lifeline Rates** — A system used by many water purveyors of providing subsidized water rates to needy individuals and those on fixed incomes for a minimum amount of water delivered.
- Lifetime Exposure** — Total amount of exposure to a substance that a human would receive in a lifetime (usually assumed to be 70 years).
- Lift Station** — (Wastewater Treatment) A wastewater pumping station that lifts the wastewater to a higher elevation when continuing the sewer at reasonable slopes would involve excessive depths of trench. Also, an installation of pumps that raise wastewater from areas too low to drain into available sewers. These stations may be equipped with air operated ejectors or centrifugal pumps. Sometimes called a *Pump Station*, but this term is usually reserved for a similar type of facility that is discharging into a long *Force Main*, while a lift station has a discharge line or force main only up to the downstream gravity sewer. Throughout this manual when we refer to lift stations, we intend to include pump stations. Such facilities are required in areas with a flat topography.
- Lifts** — Layers of loose soil. Used to specify how much loose soil should be laid down at a time before it must be compacted or wrapped in geotextile fabrics.
- Light-and-Dark Bottle Technique** — A method used to determine the extent of *Photosynthesis* in an aquatic *Ecosystem*. Duplicate portions of a water sample are collected. One portion is *Incubated* in a clear bottle, and the other is incubated in a dark, light-impermeable bottle. Following incubation for a prescribed time period, the net uptake of carbon dioxide in each is measured and compared.
- Light-Attenuation Coefficient** — A measure of water clarity. Light is attenuated according to the Lambert-Beer equation

$$I = I_0 e^{-\lambda L}$$

where I_0 is the source light intensity, I is the light intensity at length L (in meters) from the source λ is the light-attenuation coefficient, and e is the base of the natural logarithm. The light attenuation coefficient is defined as

$$\lambda = -1/L \log_e I/I_0$$

Light Water — (Chemistry and Physics) Ordinary water, H_2O , as compared to *Heavy Water*.

Light Water Reactor (LWR) — A nuclear power plant which uses ordinary *Water* (H_2O) as distinguished from one that uses *Heavy Water* (D_2O) or *Deuterium Oxide*. Fission energy is released in the form of heat and is transferred to a conventional steam cycle which generates electric energy. Heat generated by the fission of the uranium fuel raises the temperature of the water, which is then pumped to heat exchange units for the production of steam and subsequent generation of electricity. The process results in a continuous transfer of heat from the reactor to the outside. The water also functions as a moderator to reduce the energy level of neutrons released by the fission process in order to allow the neutrons to promote additional fission events. The light-water reactor is the most common type of nuclear reactor operated in the United States.

Lignin — The organic substance that holds together the individual fibers of wood. Lignin is responsible for the dark color in pulp mill effluents.

Limb (Rising or Falling) — The part of the *Hydrograph* in which the discharge is steadily increasing or decreasing.

Lime — Calcium oxide (CaO) used in many water and wastewater treatment operations such as softening, coagulation and phosphorus removal. Also referred to as *Quicklime*.

Limestone — (Geology) A sedimentary rock composed of calcite, or calcium carbonate (CaCO₃), and sometimes containing shells and other hard parts of prehistoric water animals and plants. When chemical conditions are right, some calcite crystallizes in sea water and settles to the bottom to form limestone.

Limestone Scrubbing — The use of a *Limestone* and water solution to remove gaseous stack-pipe sulfur before it reaches the atmosphere.

Limicolous — Living in mud.

Liming — The application of lime to land, primarily to reduce soil acidity and supply calcium for plant growth. Liming an acid soil to a pH of about 6.5 is desirable to maintain a high degree of availability of most of the nutrient elements required by plants.

Limited Degradation — An environmental policy permitting some degradation of natural systems but terminating at a level well beneath an established health standard.

Limited Water-Soluble Substances — (Water Quality) Water pollution chemicals that are soluble in water at less than one milligram of substance per liter of water.

Limiting Factor — A condition whose absence or excessive concentration is incompatible with the needs or tolerance of a species or population and which may have a negative influence on their ability to thrive and/or survive. A factor such as temperature, light, water, or a chemical that limits the existence, growth, abundance, or distribution of an organism.

Limnetic — Referring to a standing water *Ecosystem* (ponds or lakes); of, relating to, or inhabiting the open water of a body of fresh water, as a limnetic environment or *Limnetic Zone*.

Limnetic Zone — The open water of a pond or lake supporting *Plankton* growth. Contrast with *Profundal Zone*.

Limnology — (1) The branch of *Hydrology* pertaining to the study of freshwater, the aquatic environment and its life; the study of the physical, chemical, hydrological, and biological aspects of fresh water bodies. (2) The study of the functional relationships and productivity of freshwater biotic communities as they are affected by the dynamics of physical, chemical and biotic environmental parameters. Related terms include *Limnological*, *Limnologic*, and *Limnologist*.

Limnology Hydrobiologist — A person who undertakes the biological study of bodies of water.

Lindane — A pesticide that causes adverse health effects in domestic water supplies and is toxic to freshwater fish and aquatic life.

Lineament — (Geology) An essentially rectilinear topographic feature resulting from a fault or zone of faulting. Frequently such areas provide indications of available groundwater sources.

Linear — (Statistics) Indicating a constant (straight-line) relationship between two *Variables*. Linearity constitutes one of the principal underpinnings of the *Classical Linear Regression (CLR) Model*. Also see *(Inherently) Linear Model*, below.

(Inherently) Linear Model — (Statistics) *Regression Models* which can be expressed in a linear form by an appropriate transformation of the *Variables*. It is this transformation, as represented by the model's *Parameters*, or *Coefficients*, that determines the linearity of the model. For example, the model

$$Y = \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \epsilon$$

is inherently linear because it is linear with respect to the coefficients $\beta_2, \beta_3, \dots, \beta_n$. Other transformations resulting in inherently linear models are as follows:

Polynomial Model:

$$Y = \beta_1 + \beta_2 X_2 + \beta_3 X_2^2 + \epsilon$$

Log-Log Model:

$$\log Y = \alpha_1 + \alpha_2 \log X_2 + \alpha_3 \log X_3 + \epsilon$$

Multiplicative Model:

$$Y = \gamma_1 X_2^{\gamma_2} X_3^{\gamma_3} \epsilon$$

Exponential Model:

$$Y = \exp(\beta_1 + \beta_2 X_2 + \beta_3 X_3) \epsilon$$

Reciprocal Model:

$$Y = 1/(\beta_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon)$$

Semilog Model:

$$Y = \beta_1 + \beta_2 \log X_2 + \epsilon$$

Linear Programming — (Mathematics) A mathematical method used to determine the most effective allocation of limited resources between competing uses when both the objective (e.g., profit, cost, or output) and the restrictions (constraints) on its attainment can be quantified as a system of linear equations representing equalities or inequalities.

Linearity — (1) A constant relationship; a graphical straight-line relationship between two variables. (2) (Measurement) How

closely an instrument measures actual values of a variable through its effective range; a measure used to determine the accuracy of an instrument.

Lined Waterway or Outlet — A waterway or outlet with an erosion-resistant lining of concrete, stone, or other permanent material. The lined section extends up the side slopes to a designed height.

Liner — (1) (Water Quality) A low-permeability material, such as clay or high-density polyethylene, used for the bottom and sides of a landfill. The liner retards the escape of *Leachate* from the landfill to the underlying groundwater. (2) An insert or sleeve for sewer pipes to prevent leakage or infiltration.

Line Storm — A violent storm or a series of storms of rain and wind believed to take place during the equinoxes.

Linguoid Ripple Mark — (Geology) An aqueous ripple mark with tongue-shaped projections pointing into the current and formed by water moving along the bottom of shallow streams. Also referred to as a *Cuspate Ripple Mark* or *Linguoid Current Ripple*.

Lining — With reference to a canal, tunnel, shaft, or reservoir, a coating of asphaltic concrete, reinforced or unreinforced concrete, shotcrete, rubber or plastic to provide water tightness, prevent erosion, reduce friction, or support the periphery of the structure. May also refer to the lining, such as steel or concrete, of an outlet pipe of conduit of a dam or reservoir.

Lining (Hydraulics) — A protective covering over all or part of the perimeter of a reservoir or a conduit to prevent seepage losses, withstand pressure, resist erosion, reduce friction, or otherwise improve conditions of flow.

Lipid — Any of a group of organic compounds, including the fats, oils, waxes, steroids, and triglycerides, that are insoluble in water but soluble in common organic solvents, are oily to the touch, and together with carbohydrates and proteins constitute the principal structural material of living cells. Many environmental contaminants such as organochlorine pesticides are lipophilic.

Liquefaction — (1) (General) The act or process of making or becoming liquid; especially the conversion of a solid into a liquid by heat, or of a gas into a liquid by cold or pressure. (2) (Soils) The sudden and spontaneous large decrease of the shearing resistance of a cohesionless soil, caused by a collapse of the structure from shock or other types of strain and associated with a sudden but temporary increase in the pore-fluid pressure resulting in the temporary transformation of the material into a fluid mass.

Liquefy, also Liquify — (1) To cause to become liquid. (2) To melt (a solid) by heating.

Liquid — A state of matter in which the molecules are closer and held more tightly by one another than in the gaseous state. Has a definite volume, but indefinite shape. See *Water*.

Liquid-Dominated Hydrothermal Reservoir — (Geology) A geothermal system, such as a geyser or hot spring, that primarily produces superheated water.

Liquid Fertilizer — A fluid in which the plant nutrients are in true solution.

Liquid-Filled Porosity — (Geology) In porous rock or sand formations, a condition under which pore spaces are filled with water, liquid petroleum, pressure-liquefied butane or propane, or tar.

Liquid Injection Incinerator — Commonly used system that relies on high pressure to prepare liquid wastes for incineration, breaking them up into fine droplets to allow for easier combustion.

Liquid Limit — (Geology) The minimum amount of water that, when mixed with a given sediment, will cause the sediment to flow plastically.

Liquor — (Water Quality) A liquid solution containing dissolved substances. A concentrated solution of process chemicals or raw materials added to an industrial process. Compare with *Slurry*.

Liter — The basic unit of measurement for volume in the *Metric System* equivalent to 0.001 cubic meters (10^{-3} m^3); also equal to 61.025 cubic inches or 1.0567 liquid quarts.

Lithia Water — Mineral water containing lithium salts.

Lithologic — Relating to rock, unconsolidated material, or soil.

Lithology — (Geology) (1) The scientific study of rocks, usually with the unaided eye or with little magnification. (2) Loosely, the structure and composition of a rock formation. (3) The description of rocks, especially sedimentary *Clastics* and especially in hand specimen and in outcrop, on the basis of such characteristics as color, structures, mineralogic composition, and grain size.

Lithometeor — Solid material, except ice (water), suspended in the atmosphere, as dust, smoke, or pollen. Contrasts with *Hydrometeor*.

Lithosphere — (1) The crust of the earth. That part of the earth which is composed predominantly of rocks (either coherent or incoherent, and including the disintegrated rock materials known as soils and subsoils), together with everything contained in this rocky crust. (2) The solid portion of the Earth, as compared with the atmosphere and the hydrosphere. It includes the crust and part of the upper mantle and is about 62 miles (100 kilometers) thick.

Lithotripter — A device that pulverizes kidney stones by passing shock waves through a water-filled tub in which the patient sits. The device creates stone fragments small enough to be expelled in the urine.

Litigation — To bring a dispute or claim before a court of law for decision or settlement.

Litmus — A water-soluble blue powder derived from certain lichens that changes to red with increasing *Acidity* and to blue with increasing *Basicity*.

Litmus Paper — An unsized white paper impregnated with *Litmus* and used as a Ph or acid-base indicator.

Litter — The vegetative material on the surface of the soil, referred to as the *Oi* horizon.

Little Ice Age — (Geology) An interval of about 5,500 years marked by extended climatic deterioration and the general expansion of mountain glaciers, especially in the Alps, Scandinavia, Iceland, and Alaska.

Littoral — (1) The region along the shore of a non-flowing body of water; corresponds to *Riparian* for a flowing body of water. More specifically, the zone of the sea flood lying between the tide levels. (2) (Ecology) Of or relating to the shore of a lake, sea, or other body of water. Also see *Littoral Zone*.

Littoral Current — (Oceanography) A longshore current produced by waves striking the shore at an acute angle; it moves parallel

to the shore, usually within the breaker zone.

Littoral Drift — (1) The lateral movement of water along a shoreline; waves striking a shoreline at other than right angles causing a movement of the water more or less parallel to the shoreline. Wave energy rarely, if ever, makes perfectly perpendicular contact with the shoreline. Instead, the waves hit the shoreline at an angle, causing a lateral movement of water and sediment in whichever direction the waves are angled toward. This lateral movement results in the deposition of sediment along the coastline where wave energy goes from high to low. (Geology) (2) The materials, including gravel, sand, and shell fragments, transported along the shore by the action of waves and currents moving parallel to the coastline. Also, *Longshore Drift*.

Littoral Sediments — (Geology) Accumulations of *Littoral Drift* deposited along the shore.

Littoral Transport — (Geology) (1) The process by which *Littoral Drift* is moved along the shore parallel to the coastline. (2) The movement of material along the shore by waves and currents.

Littoral Water Rights — The equivalent of *Riparian Water Rights* for a lake, reservoir, or other non-flowing body of water. As with riparian water rights, littoral water rights allow persons who own land adjacent to a body of water to make reasonable use of those waters on lands within the watershed. Littoral users share the waters among themselves and the concept of priority use (*Prior Appropriation Doctrine*) is not applicable. Under drought conditions, the lake or waterfront users also share shortages. Littoral rights cannot be sold or transferred to use on other (nonriparian) lands. Also see *Riparian Doctrine*, *Riparian Water Rights*, *Appropriative Water Rights*, *Prescribed Water Rights*, and *Reserved Water Rights*.

Littoral Zone — (1) The shallow area near the shore of a non-flowing body of water; that portion of a body of fresh water extending from the shoreline lakeward to the limit of occupancy of rooted plants. The area of a lake near the shore from the region of the highest seasonal water level to the deepest point at which attached submerged *Macrophytes* occur. (2) A strip of land along the shoreline between the high and low water levels. (Ecology) (3) The area of shallow fresh water in which light penetrates to the bottom and nurtures rooted plants. (4) The shoreline where a normal cycle of exposure and submersion by the tides occurs.

Live Spring — See *Perennial Spring*.

Live Stream — See *Perennial Stream*.

Livestock Water Use — Water use for stock watering, feed lots, dairy operations, fish farming, and other on-farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry. Also included are such animal specialties as horses, rabbits, bees, pets, fur-bearing animals in captivity, and fish in captivity. Also see *Rural Water Use*.

Living Oceans Program [National Audubon Society] — A National Audubon Society (NAS) program, conducted in cooperation with a United Nations plan intended to address problems related to the depletion of marine fish species, over-fishing, associated slaughter of seabirds, and the depletion of shark populations. The NAS program is being conducted in five critical areas:

- [1] **Species in Peril** – A recognition that many fish populations are depleted because of inadequate limits on harvest and on the size of fishing fleets and that efforts are needed to rebuild fish populations internationally;
- [2] **Seabirds** – An effort by NAS to introduce more humane means of fishing gear and specifically to replace the long-line, which consists of 25-50 miles worth of baited hooks which do not discriminate with respect to their destruction of fish or seabirds;
- [3] **Consumer Information** – Support of the publication of a consumer product called “Audubon Guide to Seafood,” which classifies food fish and crustaceans according to abundance, habitat health, management, and the effects of fishing on other species, especially bird populations;
- [4] **Marine Reserves** – A program designed to move the land-based wildlife refuge concept offshore to protect at least a representative sample of important marine habitats so that fish can mature and spawn normally, thereby helping to replenish over-fished areas and depleted fish populations; and
- [5] **Aquaculture** – An Audubon response to establish more rigorous standards for fish farming enterprises which are increasingly used as alternatives to mismanaged fisheries.

Load — The amount of material that a transporting agency, such as a stream, a glacier, or the wind, is actually carrying at a given time. Also, the amount of power delivered to a given point. In this respect:

- [1] **Base Load** = the minimum load in a stated period of time.
- [2] **Firm Load** = that part of the system load which must be met on demand.
- [3] **Peak Load** = literally, the maximum load in a stated period of time. Sometimes the term peak load is used in a general sense to describe that portion of the load above the base load.

Load Allocation (LA) — (Water Quality) The portion of the pollution *Load* of a stream attributable to human *Nonpoint Sources* (NPS) of pollution. The amount of pollution from each point source is the *Wasteload Allocation*.

Load Factor — The average electric power generated during a designated period divided by the peak generation rate occurring in the same period.

Load Line — The line on a ship indicating the depth to which it sinks in the water when properly loaded. Also referred to as *Plimsoll's Mark*.

Loading — (1) (Environmental) The quantity of a substance entering the environment (soil, water, or air). (2) The quantity of a substance (a contaminant) entering the receiving waters. Synonym for the pollution *Load* of a stream.

Loading Capacity — The greatest amount of chemical materials or thermal energy that can be added to a stream without exceeding water quality standards established for that stream.

LOAEL — Lowest-observed-adverse-effect-level; the lowest dose in an experiment which produced an observable adverse effect.

Loam — (1) A soil consisting of a friable mixture of varying proportions of clay, silt, and sand. A soil which has nearly equal proportions of silt, sand and clay. The word is used by gardeners to mean a soil that is rich in organic material, does not compact easily, and drains well after watering. (2) A rich, permeable soil composed of a *Friable* mixture of relatively equal and moderate

proportions of clay, silt, and sand particles, and usually containing organic matter (humus) with a minor amount of gravelly material. It has somewhat gritty feel yet is fairly smooth and slightly plastic. Loam may be of residual, fluvial, or *Eolian* origin, and includes many loesses and many of the alluvial deposits of *Flood Plains*, *Alluvial Fans*, and *Deltas*.

Loamy — Said of a soil (such as a clay loam and a loamy sand) whose texture and properties are intermediate between a coarse-textured or sandy soil and a fine-textured or clayey soil.

Lobate Rill Mark — (Geology) A flute cast that is formed by the action of water currents.

Lobe — A long, rounded recess of a lake. Also see *Glacial Lobe*.

Local Flooding — Flood conditions which occur over a relatively limited area.

Local (Test-Well) Site Designation [Nevada] — The local test-well site designation used in Nevada is based on the identification of a site by hydrographic area and by the official rectangular subdivision of the public lands referenced to the Mount Diablo (located east of Walnut Creek, California) base line and meridian and is based on the *Public Land Survey System (PLSS)*. Each site designation consists of four units: The first unit is the hydrographic area number. The second unit is the township, preceded by an N or S to indicate location north or south of the base line. The third unit is the range, preceded by an E to indicate location east of meridian. The fourth unit consists of the section number and letters designating the quarter section, quarter-quarter section, and so on (A, B, C, and D indicate the northeast, northwest, southwest, and southeast quarters, respectively), followed by a number indicating the sequence in which the site was recorded. For example, site 210 S12 E63 29DABC2 is in Coyote Spring Valley (hydrographic area 210). It is the second site recorded in the southwest quarter (C) of the northwest quarter (B) of the northeast quarter (A) of the southeast quarter (D) of Section 29, Township 12 South, Range 63 East, Mount Diablo base line and meridian.

Loch — A lake; also, a bay or arm of the sea especially when nearly landlocked.

Lock — (1) A section of a waterway at which the level of the water can be raised or lowered by the use of controllable gates. (2) A section of a waterway, such as a canal, closed off with gates, in which vessels in transit are raised or lowered by raising or lowering the water level of that section.

Loess (Soil) — (1) A wind-blown silt or silty clay having little or no stratification. (2) A fine-grained, yellowish-brown, extremely fertile loam deposited mainly by the wind and found widely in North America, Asia, and Europe. Such soils are highly susceptible to water erosion.

Log — (1) The record of, or the act or process of recording, events or the type and characteristics of the rock penetrated in drilling a borehole as evidenced by the cuttings, core recovered, or information obtained from electronic devices. (2) An apparatus for measuring the rate of a ship's motion through the water that consists of a block fastened to a line and run out from a reel.

Log and Safety Boom — A net-like device installed around the discharge facility of a dam to prevent logs, debris, or boaters from entering the outlet device.

Logarithm (Log) — (Mathematics) The value of the exponent that a fixed number (the base) must have to equal a given number. It is calculated as $b^x = y$, where b is the base and x is the logarithm. The base for the common logarithm is 10. As an example, the logarithm of 100 is 2 since 10^2 is equal to 100. This may also be written as $\log_{10} 100 = 2$. Also abbreviated to "log." The base of the *Natural Logarithm* is approximately equal to 2.718282.

Logarithmic — Implying a non-linear, i.e., exponential relationship.

Logarithmic Transformation — (Statistics) A transformation applied to a *Time Series* to remove exponential growth, that is, when a series grows by some percentage of itself. The logarithmic transformation is frequently used in conjunction with simple (linear) differencing, especially for series like U.S. Gross Domestic Product (GDP), the Consumer Price Index (CPI), money supplies, and other time series subject to both growth and inflation.

Logged — Sodden, especially with water, i.e. *Waterlogged*.

Logging — The technique of determining underground geologic formations by use of various devices and methods to traverse a well or bore hole.

Logistic Equation — (Ecology) An equation for population growth through time, starting from a minimum number of individuals to a maximum number in accordance with the carrying capacity of the region, described by an elongated S-shaped curve.

Logjam — A strainer dam of logs across a river. This dangerous phenomenon is common on small streams in wooded country.

Lolly Ice — (Oceanography) Seawater *Frazil*, ice crystals kept in suspension by water turbulence.

Long-Term Acceptance Rate (of Soils) — A term used to describe the permeability or porosity of various soils and their ability to drain water; usually expressed in gallons per square foot per day.

Longitudinal Profile — A graphic presentation of elevation versus distance; in channel hydraulics it is a plot of water surface elevation against upstream to downstream distance. See *Stream Profile*.

Longshore Bar — (Geology) A low, elongated ridge of sand built mainly by wave action that lies generally parallel to the shoreline and is submerged at high tide. Also referred to as *Ball*, *Barrier Bar* or *Offshore Bar*.

Longshore Trough — (Geology) A wide, elongated, shallow depression of the sea floor lying parallel to the shore.

Loop Lake — See *Oxbow Lake*.

Loop Rating — A graph of river stage with respect to discharge, in which some values for discharge are higher at certain stages when the river is rising than when it is falling, thus describing a loop with each rise and fall of the river.

Loose-Snow Avalanche — A type of *Avalanche* in snow that lacks cohesion, starting at one localized point and widening as it slides downhill.

Losing Stream — A stream or reach of a stream that is losing water by seepage into the ground. Also referred to as an *Influent Stream*. Also see *Stream*.

Loss of Waters of the United States [USACE] — Waters of the United States that include the filled area and other waters that are permanently adversely affected by flooding, excavation, or drainage as a result of the regulated activity. Permanent adverse

effects include permanent above-grade, at-grade, or below-grade fills that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. The acreage of loss of waters of the United States is the threshold measurement of the impact to existing waters for determining whether a project may qualify for an NWP; it is not a net threshold that is calculated after considering compensatory mitigation that may be used to offset losses of aquatic functions and values. The loss of stream bed includes the linear feet of stream bed that is filled or excavated. Waters of the United States temporarily filled, flooded, excavated, or drained, but restored to pre-construction contours and elevations after construction, are not included in the measurement of loss of waters of the United States.

Losses Incidental to Irrigation — The quantity of water depleted by irrigation in excess of the beneficial irrigation consumptive use.

Lost Circulation — The result of drilling fluid escaping from the borehole into the formation by way of crevices or porous media.

Lost Stream — A dried-up stream in an arid region. See *Sinking Stream*.

Lotic — (1) Of, relating to, or living in moving water. (Ecology) (2) Referring to a running water *Ecosystem* (streams and rivers).

(3) Of or relating to freshwater habitats characterized by swift-moving currents, such as rivers and streams. Compare to *Lentic*.

Lotic Environment — Characterizing aquatic communities found in running water. Also referred to as a *Lotic Habitat*.

Lotic System — A flowing body of fresh water, such as a river or stream. Compare to *Lentic System*.

Lotic Waters — Describing the waters of rivers and streams (flowing waters) as compared to *Lentic Waters* of ponds or marshes (standing waters).

Lough — (Irish) (1) A lake. (2) A bay or an inlet of the sea.

Low — (1) Situated below the surrounding surfaces as in water standing in low spots. (2) Of less than usual or average depth; shallow, as in the river is low.

Low-Level Jet (Stream) — A region of relatively strong winds in the lower part of the atmosphere which forms in advance of cyclonic storms. It also refers to a southerly wind maximum in the boundary layer common over the Great Plains at night during the spring and summer. This feature is important in the transport or advection of temperature and moisture which fuels thunderstorm development.

Low Permeability — Permeability of 0.000001 centimeters per second or less.

Low-Pressure Drain — A self-activating device to drain that portion of an irrigation pipeline or conduit whose contents could potentially enter the water supply when operation of the irrigation system pumping plant fails or is shut down.

Lower Basin States [Colorado River Basin] — Arizona, Nevada, and California. Also see *Colorado River Compact* and *Upper Basin States*.

Low Flow Frequency Curve — A graph showing the magnitude and frequency of minimum flow for a specified period of time (duration).

Low-Level Drawdown — A discharge feature of a dam allowing water to be removed from the bottom of a reservoir.

Low-Level Outlet — An opening at a low level from a reservoir generally used for emptying or for scouring sediment and sometimes for irrigation releases. Also referred to as *Bottom Outlet* or *Sluiceway*.

Low-Lying — Lying close to water or ground level as low-lying coastal areas.

Low-Pressure/Low-Volume Irrigation — Irrigation systems that apply water directly, or very near to the soil surface, either above the ground or into the air, in discrete drops, continuous drops, small streams, mist, or sprays. These include drip systems, spray systems, jet systems, and bubbler systems. Also referred to as *Micro or Trickle Irrigation*. The efficiencies of these low pressure irrigation systems range from 75 to 95 percent; however, the average of 80 percent is commonly used.

Low Tide — (Oceanography) (1) The lowest limit reached by a falling tide. The lowest level of the tide; the minimum height reached by each falling tide. (2) The time at which the tide is lowest. The high-low and low-low tides are the higher and lower of the two low tides, respective, of each tidal day. Also referred to as *Low Water*.

Low Water (LW) — (1) The lowest level of water in a body of water, such as a river, lake, or reservoir. (2) (Navigation) The depth of a navigation channel is generally referenced to the low water stage which coincides with the lowest sustained flow over a 15-day period. On most streams this is referred to as “adopted low water”; on the lower Columbia, for example, it is the “Columbia River Datum”.

Low-Water Mark (LWM) — The lowest level attained by a varying water surface level.

Lowest Annual Mean — A value used for river flow readings representing the lowest total annual volume (in acre-feet per year) and the corresponding lowest annual average rate of flow (in cubic feet per second) recorded at a specific gaging station location over a specific period of record. Also referred to as the *Low Water Year*.

Lowest Floor — (FEMA) Under the *National Flood Insurance Program (NFIP)*, this term means the lowest floor of the lowest enclosed area (including basement). The lowest floor is required to be placed at or above the Base Flood Elevation if elevated foundation construction techniques are employed.

Lowland Flooding — Inundation of the very lowest portions of *Floodplain* areas near a river, stream or lake, which are normally subject to frequent flooding; usually considered nuisance flooding.

Lowmoor Bog — (Geology) A *Bog* lying at, or slightly above or below, the *Water Table*.

LSI — Langelier Saturation Index.

L/sm² — Liter(s) per second per square meter.

LTAR (of Soils) — See *Long-Term Acceptance Rate (of Soils)*.

Lunar Day — See *Tidal Day*.

Lunar Tide — (Oceanography) The harmonic tidal constituent due solely to the tide-producing forces of the moon.

Lunate Bar — (Geology) A submerged or partly submerged crescent-shaped sand bar, often found near the entrance to a harbor or at the mouth of a stream.

Lunette — A broad, low-lying, typically crescent-shaped mound of sandy or loamy matter that is formed by the wind, especially along the windward side of a lake basin.

Lunitidal Interval — (Oceanography) The period of time between the transit (upper or lower) of the moon over the local or Greenwich meridian and a subsequent specified phase of the tide, that is, the lag time between the passage of the moon and the arrival of a tide.

LVEA — See *Lahontan Valley Environmental Alliance (LVEA) [Nevada]*.

Lysimeter — (1) An artificial device for evaluating the *Water Budget* by enclosing a block of soil, often on a scale, with equipment for monitoring inputs and outputs. (2) A field-situated tank or container filled with soil and planted to a crop. Crop consumptive use is measured by weighing or volumetrically monitoring this tank. Also a device for measuring the percolation of water through soils and for determining the soluble constituents removed in the drainage.

M

M&I (Municipal and Industrial) Water Withdrawals (Use) — Water supplied for municipal and industrial uses provided through a municipal distribution system.

Maar — A flat-bottomed, roughly circular volcanic crater of explosive origin that is often filled with water.

Macroclimate — The general large-scale climate of a large area or country, as distinguished from *Mesoclimate* and *Microclimate*.

Macroinvertebrate — An animal without a backbone, large enough to see without magnification.

Macronutrient — A chemical element necessary in relatively large amounts (usually more than one part per million [ppm] in the plant) for the growth of plants.

Macrophyte — (1) A member of the macroscopic plant life, especially of a body of water. (2) The macroscopic plants in the aquatic environment. The most common macrophytes are the rooted vascular plants that are usually arranged in zones in aquatic ecosystems and restricted in the area by the extent of illumination through the water and sediment deposition along the shoreline.

Macrophytic Algae — Algal plants large enough either as individuals or communities to be readily visible without the aid of optical magnification.

Macropore — (Geology) A minute opening in soil that is too large to hold water by capillarity. Also referred to as *Megapore*.

Macroscopic Organisms — Organisms big enough to be seen by the eye without the aid of a microscope.

Maelstrom — (1) A whirlpool of extraordinary size or violence. (2) (Oceanography) A strong, turbulent, and often destructive current caused by the meeting between a high sea and a tidal current setting in an opposing direction; sometimes characterized by an eddying, whirlpool-like flow.

Magma — (Geology) (1) Molten rock found in the mantle, beneath the crust of the earth. When forced toward the surface, magma cools and solidifies to become *Igneous* rock. (2) Molten fluids generated within the earth from which igneous rocks are derived by crystallization or by other processes of consolidation.

Magmatic Water — (1) Water driven out of *Magma* during crystallization. (2) Water contained in or derived from magma or molten rock.

Magnetic Separation — The use of magnets to separate ferrous materials from mixed municipal waste stream.

Main — A relatively large pipe in a distribution system for drinking water or in a collection system for municipal wastewater. Of or relating to utility distribution mains for transferring water. Often used in the plural, as in water mains.

Main Canal System — A canal that delivers water from a primary source of supply to several points of diversion or canal-side turnouts to smaller distribution systems.

Main Channel Pool [California] — A pool formed by mid-channel scour that encompasses greater than sixty percent of the wetted channel.

Main Stream — The largest or principal stream of a given area or drainage system. Also referred to as *Master Stream* or *Trunk Stream*.

Main Thermocline — (Oceanography) The deepest *Thermocline*, essentially unaffected by seasonal variations in surface temperature.

Master Stream — See *Main Stream*.

Mainstem — (1) The major reach of a river or stream formed by the smaller tributaries which flow into it. (2) The principal watercourse of a river, excluding any tributaries.

Major Flooding — Flood conditions resulting in extensive inundation and property damage. Typically characterized by the evacuation of people and livestock and the closure of both primary and secondary roads. Also see *Minor Flooding* and *Moderate Flooding*.

Major Landform — A subdivision of the piedmont slope or basin floor major physiographic parts that reflects a major morphogenetic process operating through a long time, or that is the prominent result of a special erosional or depositional history. Many major landforms are dissected and their original area now is occupied by *Component Landforms*.

Majors — Larger *Publicly-Owned Treatment Works (POTWs)* with flows equal to at least one million gallons per day (mgd) or servicing a population equivalent to 10,000 person, certain other POTWs having significant water quality impacts. Contrast with *Minors*.

Make Call — See *Call the River*.

Makeup Water — Water added to the flow of water used to cool condensers in electric power plants. This new water replaces condenser water lost during passage of the cooling water through cooling towers or discharged in blowdowns.

Malenclave — A body of contaminated groundwater that is surrounded by uncontaminated water.

Malezal Swamp — (Ecology) A swamp resulting from the drainage of water over a wide plain with a slight slope.

Malpais — (Geology) A Southwest United States term for rough country underlain by basaltic lava.

Management Indicator Species (MIS) — (Environmental) A species selected because its welfare is presumed to be an indicator of the welfare of other species in the habitat. A species whose condition can be used to assess the impacts of management actions on a particular area. Managing for these species usually requires significant allocations of land or resources. Also see *Indicator*

Species.

Management Scenario — (Ecology) A description of future conditions expected to result from the general implementation of a broad resource management strategy. Management scenarios are developed to explore the biological and social implications, tradeoffs, and uncertainties of *Ecosystem Management* rather than present a range of options for site specific adoption (management alternatives).

Managerial Controls — (Irrigation) Methods of nonpoint source pollution control based on decisions about managing agricultural wastes or application times or rates for agrochemicals.

Manganese Nodules — Concretions, primarily of manganese salts, covering extensive areas of the ocean floor.

Mangrove — Tropical evergreen trees and shrubs that have stilt like roots and stems, and often form dense thickets along tidal shores. Also see *Mangrove Swamp*.

Mangrove Swamp — (Ecology) (1) A swamp at the fringe of tropical saltwater systems characterized by an abundance of low to tall trees, especially mangrove trees, that have dense root systems ranging well beyond their trunks. (2) A tidal swamp forest populated by plant species capable of growth and reproduction in areas that experience periodic tidal submergence in seawater with a resulting increase in saline conditions. These forests develop along coastal regions in tropical climates. Mangrove swamps are dominated by trees referred to as red mangrove, *Rizophora mangle*, black mangrove, *Avicennia germinans*, and white mangrove, *Laguncularia racemosa*. Typically, these trees have large, exposed root systems.

Manifold — A large pipe to which a series of smaller pipes are connected. Also called a *Header*.

Marigram — (Oceanography) A graphic representation of the rise and fall of the tide in the form of a curve, the height represented by ordinates (y-axis) and the time represented by abscissas (x-axis).

Manmade Lake — Any manmade body of water, including lakes, ponds, lagoons, and reservoirs (excluding tank-type reservoirs which are fully enclosed and contained), that are filled or refilled with water or reclaimed wastewater from any source and used for recreational, scenic, or landscape purposes, except swimming pools.

Manometer — (1) An instrument for measuring pressure which usually consists of a U-shaped tube containing a liquid, the surface of which in one end of the tube moves proportionally with changes in pressure on the liquid in the other end. The term is also applied to a tube-type differential pressure gage. (2) An instrument for measuring pressure. Usually, a manometer is a glass tube filled with a liquid that is used to measure the difference in pressure across a flow-measuring device such as an orifice or Venturi meter. The instrument used to measure blood pressure is a type of manometer.

Mantle — (Geology) (1) The division of the earth's interior between the core and the crust. It is composed mainly of silicate rock and is around 2,900 kilometers (1,800 miles) thick. (2) The soil or other unconsolidated rock material more commonly referred to as overburden.

Mantle Ice — See *Ice Sheet*.

Marcel's Principle — See *Principle of Constant Proportions*.

Mare Clausum — A navigable body of water, such as a sea, that is under the jurisdiction of one nation and closed to all others.

Mare Liberum — A navigable body of water, such as a sea, that is open to navigation by vessels of all nations.

Mare Nostrum — A navigable body of water, such as a sea, that is under the jurisdiction of one nation or that is shared by two or more nations.

Marginal Chlorination — Application of chlorine to produce the desired total chlorine residual without reference to the relative amounts of free or combined chlorine present.

Mariculture — The cultivation of marine organisms for use as a food resource. Compare to *Aquiculture*.

Marina — A water-based facility used for storage, service, launching, operation, or maintenance of watercraft.

Marine — (Oceanography) (1) Of or pertaining to the sea; having to do with the ocean or the things peculiar to the ocean. (2) A system within the *Wetlands and Deepwater Habitat Classification System*. Also see *Deepwater Habitats* and *Wetlands*.

Marine Abrasion — (Geology) The erosion of the seafloor by the movement of wave-agitated sediment. Also referred to as *Wave Erosion*.

Marine Biocycle — (Ecology) A division of the biosphere that includes all marine organisms.

Marine-Cut Platform — (Geology) A uniformly, gently sloping surface produced by water erosion or other marine processes. Also referred to as *Marine-Cut Terrace*.

Marine Debris — Marine, coastal, or aquatic debris is one of the more wide-spread pollution problems threatening the coastal waters of the United States and other aquatic habitats. Marine debris consists of trash floating on the ocean's surface or washed up on beaches. Debris comes from many sources, including: beachgoers; improper disposal of trash on land, stormwater runoff and combined sewer overflows to rivers and streams; ships and other vessels; and offshore oil and gas platforms. The *U.S. Environmental Protection Agency (EPA)* is one federal agency actively involved in funding efforts to stem this source of marine pollution to include providing financial support to the International Beach Cleanups organized by the Center for Marine Conservation; national marine debris information offices; public service announcements; and the development of methods for statistical volunteer cleanup efforts to gather data to assess trends in beach debris.

Marine Environment — (Ecology) The area that takes up about three-fourths of the earth's surface and includes its oceans and seas, all of which have a system of tides and waves, a high saline content, and a variety of life forms.

Marine Life — Plants and animals of the sea, from the high-tide mark along the shore (also see *Shore Life*) to the depths of the ocean. These organisms fall into three major groups: (1) *Benthos* – plants such as kelp and animals such as brittle stars that live on or depend on the bottom; (2) *Nekton* – swimming animals such as fishes and whales that move independently of water currents; and (3) *Plankton* – various small to microscopic organisms that are carried along by the currents.

Marine Littoral Faunal Region — (Ecology) A division of the earth's surface that includes all marine animals.

Marine Marsh — (Ecology) A flat piece of land near the sea, usually covered with water at high tide.

Marine Protection, Research, and Sanctuaries Act (MPRSA) [EPA] — A 1972 federal law that includes provisions requiring citizens of the United States to obtain a permit from the *U.S. Environmental Protection Agency (EPA)* before disposing of materials in the oceans. Subsequent amendments to the act have limited the types of waste that may be permitted for ocean disposal.

Marine Sanitation Device — Any equipment or process installed on board a vessel to receive, retain, treat, or discharge sewage.

Marine Snow — (Oceanography) Downward-drifting particles of living and dead organisms, including some inorganic material; sometimes suspended and concentrated at density boundaries such as *Thermoclines*.

Marine (Nautical) Surveying [NOAA] — The branch of surveying that comprises a topographic survey of the coast and a hydrographic survey of adjacent waters. Also see *National Oceanic and Atmospheric Administration (NOAA)*.

Marine Zonation — (Oceanography) (1) A system that divides the ocean into two levels and many subdivisions: (2) The *Benthic* division, which includes the sea bottom, and the *Pelagic* division, which includes the open water.

Maritime Law — Branch of law relating to commerce and navigation on the high seas and on other navigable waters. Specifically, the term refers to the body of customs, legislation, international treaties, and court decisions pertaining to ownership and operation of vessels, transportation of passengers and cargo on them, and rights and obligations of their crews while in transit.

Mark — (Nautical) A knot or piece of material placed at various measured lengths on a lead line to indicate the depth of the water, or, more generally, measurement indicators of water depth, e.g., a *Plimsoll mark*.

Marl — A mixture of clays, carbonates of calcium and magnesium, and remnants of shells, forming a loam useful as a fertilizer.

Marl Lakes — Lakes in which solid calcium carbonate precipitates during periods of high photosynthesis forming a characteristic marl bench in the *Euphotic Zone*.

Marsh — (Ecology) (1) A tract of treeless wetland that supports a dense variety of vegetation, principally grasses. (2) A term frequently associated with *Wetlands*. An area of soft, wet, low-lying land, characterized by grassy vegetation that does not accumulate appreciable peat deposits and often forming a transition zone between water and land. A tract of wet or periodically inundated treeless land, usually characterized by grasses, cattails, or other monocotyledons (sedges, lilies, irises, orchids, palms, etc.). Marshes may be either fresh or saltwater, tidal or non-tidal.

MARSH (Program) [DU] — See *Matching Aid to Restore States Habitat Program [DU]*.

Marsh Funnel Viscosity — Commonly called the funnel viscosity. The marsh funnel viscosity is reported as the number of seconds required for 1 quart (946 me) of a given fluid to flow through the marsh funnel.

Marsh Gas — Gas produced during the decomposition of organic material buried in wetland soils. The primary gas produced is *Methane*, CH₄.

Marshland — Treeless land in which the water table is at, above, or just below the surface of the ground; it is dominated by grasses, reeds, sedges, and cattails. These plants typify *Emergent Vegetation*, which has its roots in soil covered or saturated with water and its leaves held above water.

Marsh, Tidal — A low, flat area traversed by interlacing channels and tidal sloughs and periodically inundated by high tides. Vegetation in such areas usually consists of salt-tolerant plants, or *Halophytes*.

Mass Curve — A graph of the cumulative values of a hydrologic quantity (such as precipitation or runoff), generally as the *Ordinate* (y-axis), plotted against time or date as the *Abscissa* (x-axis). Mass curves may also be used to show the excavated or filled material per unit of distance for a canal or other earth structure.

Mass Movement — (Geology) (1) Unit movement of a portion of the land surface as in creep, landslide, or slip. (2) The downslope movement of a portion of the land's surface (i.e., a single landslide or the gradual downhill movement of the whole mass of loose earth material) on a slope face. All movement of soil and bedrock materials occurring below the soil surface such as landslips, landflows, rock slides, slumps, etc.

Mass Movement Deposits — In valley sediment deposition, mass movement deposits consist of earthflow, debris avalanche, and landslide deposits commonly intermixed with marginal colluvium; mudflows usually follow channels but also spill overbank. See *Valley Sediment Deposits*.

Mass Spectrometry — An analytical technique wherein ions are separate according to their ratio of charge to mass. From the mass spectrum produced, the atomic weight of the particle can be deduced.

Mass-Wasting — A variety of processes by which large masses of earth materials are moved by gravity either slowly or quickly from one place to another.

Matched Terrace — See *Paired Terrace*.

Matching Aid to Restore States Habitat (MARSH) Program [DU] — *Ducks Unlimited's (DU)* MARSH program creates a positive fund-raising atmosphere through the acquisition and enhancement of waterfowl habitat within each state. This reimbursement program provides matching funds and grants to public and private agencies and organizations within each state based on a percentage of DU's net annual grassroots fundraising in that state plus any unused MARSH funds from the previous year. MARSH projects develop, maintain, restore, and preserve wetland and associated upland habitat in the United States. Under the program, projects oriented towards protecting or restoring habitats within North American Waterfowl Management Plan Joint Venture areas receive first consideration. The MARSH Donor program allows individuals, corporations, foundations, and other organizations the opportunity to target funds to a particular MARSH project. Because all MARSH projects must meet minimum biological and cost-efficiency standards, it is preferred that donor projects be selected from existing approved or completed projects.

Mathematical Model — (1) Model used during risk assessment to perform extrapolations. (2) A representation of physical laws or processes expressed in terms of mathematical symbols and expressions (i.e., equations). The model is used as a basis for computer programs for examining the effect of changing certain variables in the analysis of the effect of flow changes in a water delivery system, for example. Also see *Econometric Model Building*.

Matric Potential — The work per unit quantity of pure water that has to be done to overcome the attractive forces of water molecules and the attraction of water to solid surfaces. The matric potential is negative above a water table and zero below a free water table.

Matrix — (1) Solid framework of a porous material or system. (2) The material in which an environmental sample is embedded or contained, whether it is soil, water, dried biomass, or other substance. (3) The rock containing a mineral or metallic ore. (4) The principal phase or aggregate in which another constituent is embedded.

Matrix Interference — The adverse influence of the environmental sample *Matrix* on the ability to detect the presence or amount of a chemical substance in the sample.

Matter — Anything which is solid, liquid, or gas and has mass.

Mattress — (Environmental) A blanket of poles, brush, or other material interwoven or otherwise lashed together and weighted with rock, concrete blocks, or held in place to cover an area subject to scouring by flowing water.

Maturity — (1) In the development of a stream, the stage at which the stream reaches its maximum efficiency, characterized by the attainment of a profile of equilibrium and a velocity sufficient to carry the load delivered to it. (Geology) (2) In the topographic development of a landscape or area, the second stage in the cycle of erosion, characterized by maximum topographic differentiation. Also referred to as *Topographic Maturity*. (3) In the development of a shore or coast, the stage that starts when a profile of equilibrium is reached.

Masonry Dam — A dam constructed mainly of stone, brick, or concrete blocks that may or may not be joined with mortar. A dam having only a masonry facing should not be referred to as a masonry dam. Also see *Dam*.

Maximum Acceptable Toxicant Concentration (MATC) — The highest concentration at which a pollutant can be present and not exert an adverse effect on the *Biota*, used to experimentally determine the toxicity of the chemical.

Maximum Beneficial Groundwater Use [EPA] — Within the range of reasonably expected uses, the maximum (or highest) beneficial groundwater use warrants the most stringent groundwater cleanup levels.

Maximum Contaminant Level (MCL) [EPA] — (1) The maximum permissible level of a contaminant in drinking water provided to the public. This federally enforceable standard is set as close as possible to the *Maximum Contaminant Level Goal (MCLG)* with consideration given to the cost and achievability of the level of the current treatment technology. (2) Legally enforceable standards regulating the maximum allowed amount of certain chemicals in drinking water. MDLs must be met by the time water reaches an individual's property. (3) The designation given by the *U.S. Environmental Protection Agency (EPA)* to water quality standards promulgated under the *Safe Drinking Water Act (SDWA)* (Public Law 93–523). As prescribed by the EPA after research of a contaminant, the MCL is the greatest amount of a contaminant that can be present in drinking water *without* causing a risk to human health. MCLs are set for certain inorganic and organic chemicals, turbidity, coliform bacteria, and certain radioactive materials. Also see *Drinking Water Standards* and *Drinking Water Standards [Nevada]*, *Water Contaminants*, *Water Treatment Disinfectants*, *Water Treatment Processes*, *Water Treatment Technologies*, *Water Quality Threats*, and *Waterborne Diseases*.

Maximum Contaminant Level Goal (MCLG) [EPA] — (1) The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. Maximum contaminant level goals are non-enforceable health goals. (2) The designation given by the *U.S. Environmental Protection Agency (EPA)* to water quality standards promulgated under the *Safe Drinking Water Act (SDWA)* (Public Law 93–523). This is a number which is associated with no adverse health effects. If someone drinks water for a lifetime containing the contaminant at this level, there should be no ill effects. As implied by the name, this number is a goal, not an enforceable standard. For chemicals which are believed to cause cancer (carcinogens), the MCLG is set at zero because there is no known safe level for this type of chemical.

Maximum Depth (Reservoir) — The greatest depth of the body of water measured in feet and 10ths of feet.

Maximum Holding Time — The longest time period that water samples can be retained between the taking of the sample and the laboratory analysis for a specific material before the results are considered invalid. The times vary from none in the case of the test for residual chlorine levels to six months for the testing of radioactivity. Some types of analyses require that preservatives be added to the sample, and some require storage of samples at refrigerated temperatures.

Maximum Probable Flood — The largest flood for which there is any reasonable expectancy.

Maximum Storage Capacity — The volume in acre-feet in the reservoir at the crest of the dam.

Maximum Sustainable Yield — The greatest amount of a renewable natural resource (e.g., forests or wildlife) that can be removed without diminishing the continuing production and supply of the resource.

Maximum Thermometer — An instrument used to measure the highest temperature since its last setting. A constriction near the bulb prevents the mercury from returning to the bulb as the temperature falls.

Maximum Tolerated Dose — See *MTD*.

Maximum Total Trihalomethane Potential (MTTP) — The maximum concentration of total *Trihalomethanes* produced in a given water containing a disinfectant residual, after 7 days at 25 degrees Celsius or above.

Maximum Water Surface (Reservoir) — The maximum water-surface elevation is the highest water surface elevation for which the dam is designed. It is also the top of the surcharge capacity.

Mayordomo — A Spanish word used in the Southwestern United States to identify the individual responsible for overseeing water allocation and maintenance of the water conveyance systems. Used synonymously for water commissioner or ditch rider.

MBAS (Methylene Blue Active Substances) — (1) Generally interpreted as an indication of the presence of detergents in a solution. These substances are used in surfactants or detergents. (2) Any material which forms a blue colored salt with methylene blue, but generally interpreted as an indication of the presence of detergents in solution.

MCL — See *Maximum Contaminant Level*.

MCLG — See *Maximum Contaminant Level Goal*.

MCRT — See *Mean Cell Residence Time*.

MDL — Method Detection Limit.

Meadow — (1) (Ecology) An area of moist low-lying grassland usually along a watercourse supporting a more dense stand of grasses and perhaps dwarf shrubs as compared to adjacent more arid uplands. An expanse of open land that is mainly covered with grasses, especially such an area at a high elevation. (2) (Agriculture) An expanse of grassland used for pasture or as a hayfield.

Meadow, Dry — An area where during the spring, early summer, and in some open winters there is a greenup of succulent vegetation. These areas are relatively few in number and highly important for sustaining animal populations within whose habitat these meadows exist. During the summer and fall there is normally dry vegetation.

Meadow, Wet — A perennial wet area where the water table is maintained at or close to the ground surface to maintain shallow rooted water-dependent vegetative complexes.

Mean — (Statistics) The sum of a set of observations divided by the number of observations. Also referred to as *Arithmetic Mean* and *Sample Mean*. Compare to *Mode* and *Median*.

Mean Annual Flood — The average of all the annual flood stages or discharges of record. It may be estimated by regionalization, correlation, or any other process that can furnish a better estimate of the long-term average than can the observed data. Some investigators arbitrarily define the mean annual flood as the stage or discharge having an exceedence interval of 2.33 years.

Mean Annual Precipitation — The average of all annual precipitation values known, or an estimated equivalent value derived by such methods as regional indexes or *Isohyetal* maps.

Mean Annual Runoff — The average value of all annual runoff amounts usually estimated from the period of record or during a specified base period from a specified area.

Mean Annual Temperature — The average of the daily maximum and minimum temperatures.

Mean Cell Residence Time (MCRT) — (Wastewater Treatment) An expression, measured in days, of the average time that a microorganism will spend in the *Activated Sludge Process*. The MCRT in days = (Total Suspended Solids in Activated Sludge Process, lbs) divided by the (Total Suspended Solids Removed From Process, lbs/day). Operators at different plants calculate the Total Suspended Solids (TSS) in the Activated Sludge Process, in lbs, by three different methods: (1) TSS in the Aeration Basin or Reactor Zone, in lbs.; (2) TSS in Aeration Basin and Secondary Clarifier, in lbs.; or (3) TSS in Aeration Basin and Secondary Clarifier Sludge Blanket, in lbs. These three different methods make it difficult to compare MCRTs in days among different plants unless everyone uses the same method.

Mean Concentration of Suspended Sediment — The time-weighted concentration of suspended sediment passing a stream section during a 24-hour day.

Mean Current — (Oceanography) The average flow rate and direction of an ocean current, as measured over a considerable period of time at a specified point.

Mean Depth — The average depth of water in a stream, channel, or conduit, calculated by dividing the cross-sectional area of the stream by its width at the surface.

Mean Discharge — The arithmetic mean of individual daily mean discharges during a specific period.

Mean Free Path — The average distance that a molecule in a fluid (air or water) moves before colliding with another molecule.

Mean High Water (MHW) — The average height of the high water over 19 years.

Mean Higher High Tide — The average height of the higher of two unequal daily high tides over 19 years.

Mean Low Water (MLW) — The average height of the low water over 19 years.

Mean Lower Low Water — The average height of the lower of two unequal daily low tides over 19 years. Tides of the northeastern Pacific Ocean are characterized as mixed, with two unequal highs and two unequal lows daily. The plane of reference for navigation channels is the long term average of the daily lower lows, termed mean lower low water.

Mean Monthly Temperature — The average of the mean monthly maximum and minimum temperatures.

Mean River Level — At any point on a river, the average height of the surface for all stages of the tide over a given period, usually 19 years.

Mean Sea Level (MSL) — (1) The level of the surface of the sea between mean high and mean low tide; used as a reference point for measuring elevations. (2) The average height of the sea for all stages of the tide over a nineteen year period, usually determined from hourly height observations on an open coast or in adjacent waters having free access to the sea. (3) (FEMA) For purposes of the *National Flood Insurance Program (NFIP)*, the *National Geodetic Vertical Datum (NGVD)* of 1929 or other datum, to which base flood elevations shown on a community's *Flood Insurance Rate Map (FIRM)* are referenced.

Mean Tide Level — A plane midway between mean high water and mean low water.

Meander — (1) A loop-like bend in the course of a river. The turn of a stream, either live or cut off. The winding of a stream channel in the shape of a series of loop-like bends. (2) One of a series of bends, twists, curves, or other such shifts in the course of a stream or river. (3) A sinuous channel form in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other side (point bars). (4) A typically sinusoidal curve characteristic of some stream systems. It is dynamic in form and tends to constantly shift its position by erosion of the concave banks (outer or longer bank of a river bend) and deposition along the convex bank (inner, or shorter bank of a river bend). Under ideal conditions, a meander system will migrate downstream in an orderly progression along a central axis. Also see *Meandering Channels* and *Deformed Meanders*.

Meander Amplitude — The distance between points of maximum curvature of successive meanders of opposite phase in a direction normal to the general course of the *Meander Belt*, measured between centerlines of channels.

Meander Bar — See *Point Bar*.

Meander Belt — (1) The zone along a valley floor that encloses a *Meandering Stream*. (2) That part of a flood plain between two lines tangent to the outer bends of all meanders.

Meander Breadth — The distance between the lines used to define the *Meander Belt*.

Meander Core — (Geology) (1) A hill that is completely or almost completely encircled by a stream meander. Also referred to as *Rock Island*. (2) An isolated hill that is the remnant of a meander spur. Also referred to as *Cutoff Spur*.

Meander Length — The distance in the general course of the meanders between corresponding points of successive meanders of the same phase.

Meander Line — A line delineated by government survey for the purpose of defining the bends or windings of the banks of a stream or the shore of a body of water, and as a means for ascertaining the quantity of land embraced by the survey.

Meander Niche — (Geology) A crescent-shaped opening formed on a cave wall by stream erosion. Also referred to as *Wall Niche*.

Meander Plain — (Geology) a level or gently sloping plain formed as a result of lateral accretion or by the meandering process.

Meander Scar — (Geology) (1) A crescent-shaped indentation on the face of a bluff or valley wall formed by the lateral expansion of a *Stream Meander* undercutting the bluff. Also referred to as a *Meander Scarp*. (2) An area that was once inhabited by a meandering stream.

Meander Scarp — See *Meander Scar*.

Meander Spur — (Geology) An undercut, high land structure that projects out into the concave part of, and is enclosed by, a *Stream Meander*.

Meandering Channels — Channels which follow a winding or tortuous course. Strictly speaking, they are distinguished from a Tortuous Channel, the alignment of which is essentially fixed by geologic or geographic conditions. By contrast, the alignment of a meandering channel tends to continuously shift by local erosion and rebuilding of the stream's banks. The majority of the problems arising in channel control are to be found with respect to meandering channels as these are streams in which bank erosion most commonly occurs. The stream meander of such channels is essentially a sinusoidal curve. It is dynamic in form and tends to constantly shift its position by erosion of the concave banks (outer or longer bank of a river bend) and deposition along the convex bank (inner, or shorter bank of a river bend). Under ideal conditions, a meander system will migrate downstream in an orderly progression along a central axis. Stream meandering is measured in terms of a Sinuosity Ratio, which is also referred to as the *Tortuosity Ratio*. Using the ratio of channel distance to valley distance, sinuosity ratios of 1.0-1.2 are typically considered as evidencing minor meandering, ratios of 1.2-1.5 show appreciable meandering, and a ratio greater than 1.5 is considered to be severe meandering.

Meandering Stream — A stream that has a pattern of consecutive *Meanders*. Also referred to as *Snaking Stream*.

Meanders — A series of regular and looplike bends in the course of a stream.

Measurement Uncertainty — The estimated amount by which the measured quantity may depart from the true value.

Measuring Point (MP) — An arbitrary permanent reference point from which the distance to water surface in a well is measured to obtain water level.

Measuring Weir — A shaped notch, typically in rectangular, trapezoidal, or triangular shape, through which flowing water is measured.

Mechanical Aeration — The use of mechanical energy to inject air into water to cause a waste stream to absorb oxygen.

Mechanical Dispersion — Process whereby solutes are mechanically mixed during advective transport, caused by the velocity variations at the microscopic level. Synonymous with *Hydraulic Dispersion*. Also see *Coefficient of Mechanical Dispersion*.

Mechanical Turbulence — The erratic movement of air or water influenced by local obstructions.

Median — (Statistics) In a set of observations, the middle-most value with an equal number of observations lying above and below the median value. Also see *Mean* and *Mode*.

Median Stream Flow (Median Hydro) — The rate of discharge of a stream for which there are equal numbers of greater and lesser flow occurrences during a specified period.

Median Tolerance Limit — The concentration of a test substance at which just 50 percent of the test animals are able to survive for a specified period of exposure.

Mediterranean — Surrounded nearly or completely by dry land. Used of large bodies of water, such as lakes or seas.

Medithermal — (Climatology) The present period of climatological conditions, beginning approximately 4,500 years ago and following the warmer *Altitheal* period. Also see *Anathermal*.

Medium-Size Water System — A water system that serves greater than 3,300 persons and less than or equal to 50,000 persons.

Megawatt (Mw) — A unit of electricity equivalent to 1 million watts or 1,000 kilowatts (Kw).

Melt — To be changed from a solid to a liquid state by application of heat or pressure or both.

Melting — The changing of a solid into a liquid as in changing ice to water.

Melting Point — The temperature at which a solid changes to a liquid. The temperature will vary, and is consistent at equal temperatures and pressures, for each element or solid. At a standard barometric pressure of one atmosphere, water will change from a solid to a liquid at 0EC (32EF).

Meltwater (or Melt Water) — Water that comes from the melting ice of a glacier or a snow bank.

Membrane — A plastic material used in the electrodialysis and reverse osmosis processes. Electric current is the driving force that moves salt ions through solution in electrodialysis, and hydraulic pressure the driving force in reverse osmosis. More properly referred to as a semipermeable membrane.

Membrane Filter — (1) A thin microporous material of specific pore size used to filter bacteria, algae, and other very small particles from water. (2) Filter made of plastic or modified cellulose and having a known pore diameter. Such filters are used in the bacteriological examination of water and the separation of suspended matter before laboratory analyses. In addition to their analytical use, these filters are also used for public health purposes as well as for the sterilization of liquids. The membranes are available in a variety of sizes, with a diameter of 47–50 millimeters being the most common. Membrane filter water purification technologies are rapidly emerging as a viable and cost effective water treatment option for municipalities confronted

with complex regulatory issues and increasingly stringent water treatment regulations. Membranes can be used as the primary means to remove materials from water, but they can also be used in conjunction with other physical, chemical, or biological processes to either separate the phases of water treatment or isolate specific organisms. More properly referred to as a semipermeable membrane filter.

Membrane Filter Method — A procedure used to recover and count bacteria in samples of liquid substances, such as water. The liquid is drawn through a *Membrane Filter* using a slight vacuum, with the bacteria in the liquid being retained on the filter. The filter disk is then transferred to a medium suitable for the growth and incubation of the bacteria.

Membrane Filtration — The use of a membrane, or more properly, a semipermeable membrane, to separate substances when a driving force is applied across the membrane. Once considered a viable technology only for desalination, membrane processes are increasingly employed for the removal of bacteria and other microorganisms, particulate material, and natural organic material which can impart color, tastes, and odors to water and react with disinfectants to form *Disinfection Byproducts (DBP)*. Due to their greater effectiveness, waste stream disposal, at up to 15-25 percent (and higher for the RO process) of the total treated water volume, is a significant problem with membrane treatment systems. Pressure-driven membrane filtration processes include:

- [1] **Microfiltration (MF)** – Loosely defined as a membrane separation process using membranes with a pore size of approximately 0.03 to 10 microns, a molecular weights cutoff (MWCO) of greater than 100,000 daltons, and a relatively low feedwater operating pressure of approximately 100 to 400 kPa (15-60 psi). Representative materials removed by MF include sand, silt, clays, *Giardia lamblia* and *Cryptosporidium* cysts, algae, and some bacterial species. MF is not an absolute barrier to viruses; however, when used in combination with disinfection, MF appears to control these microorganisms in water.
- [2] **Ultrafiltration (UF)** – Involves the pressure-driven separation of materials from water using a membrane pore size of approximately 10,000 to 100,000 daltons, and an operating pressure of approximately 200 to 700 kPa (30-100 psi). UF will remove all microbiological species removed by MF (partial removal of bacteria), as well as some viruses (but not an absolute barrier to viruses) and humic materials.
- [3] **Nanofiltration (NF)** – Membranes which have a nominal pore size of approximately 0.001 microns and an MWCO of 1,000 to 100,000 daltons. Pushing water through these smaller membrane pores requires a higher operating pressure than either MF or UF. Operating pressures are usually near 600 kPa (90 psi) and can be as high as 1,000 kPa (150 psi). These systems can remove virtually all cysts, bacteria, viruses, and humic materials. They provide excellent protection from DBP formation if the disinfectant residual is added after the membrane filtration step. Because NF membranes also remove alkalinity, the product water can be corrosive and further treatment may be required. NF also removes hardness from water, which accounts for NF membranes sometimes being called “softening membranes.”
- [4] **Reverse Osmosis (RO)** – This process removes contaminants from water using a semipermeable membrane that permits only water, and not dissolved ions (such as sodium and chloride), to pass through its pores. Contaminated water is subject to a high pressure that forces pure water through the membrane, leaving contaminants behind in a brine solution. RO can effectively remove nearly all inorganic contaminants from water. RO can also effectively remove radium, natural organic substances, pesticides, cysts, bacteria, and viruses. RO is particularly effective when used in series; water passing through multiple units can achieve near zero effluent contaminant concentrations.

Meniscus — (1) The curved surface of the liquid at the open end of a capillary column. (2) The curved top of a column of liquid (water, oil, mercury) in a small tube. When the liquid wets the sides of the container (as with water), the curve forms a valley. When the confining sides are not wetted (as with mercury), the curve forms a hill or upward bulge.

Mere — (Middle English, from Old English) A small lake, pond, or marsh. Also, an expanse of standing water; a lake, pool. (Also French for sea.)

Meromictic Lake — (1) A *Stratified Lake* that does not undergo complete mixing of its water during periods of circulation, especially a lake in which the noncirculating bottom layer does not mix with the circulating upper layer. (2) A lake in which some water remains partly or wholly unmixed with the main water mass at circulation periods. The process leading to a meromictic state is called *Meromixis*. The perennially stagnant deep layer of a meromictic lake is the *Monimolimnion*. The part of the meromictic lake in which free circulation can occur is the *Mixolimnion*. The boundary between the monimolimnion and the mixolimnion is the *Chemocline*. Compare to *Dimictic Lake*.

Meromixis — A condition of permanent stratification of water masses in lakes.

Mesa — Table land, flat in nature, moderately elevated, and well drained.

Mesh — One of the openings or spaces in a screen or woven fabric. The value of the mesh is usually given as the number openings per inch. This value does not consider the diameter of the wire or fabric; therefore, the mesh number does not always have a definite relationship to the size of the hole.

Mesic — (Ecology) (1) Of or relating to organisms that require moderate amounts of moisture. (2) Describing a habitat with moderate moisture. (3) Refers to environmental conditions that have medium moisture supplies as compared to wet conditions (*Hydric*) or dry conditions (*Xeric*).

Mesoclimate — The climate of small areas of the earth's surface; it may not be representative of the general climate of the district; intermediate in scale between *Macroclimate* and *Microclimate*. Places considered in mesoclimatology include small valleys, “frost hollows”, forest clearings and open spaces in towns.

Mesohaline — Term to characterize waters with salinity of 5 to 18‰ (parts per thousand), due to ocean-derived salts.

Mesopelagic Zone — (Oceanography) The *Pelagic* environment between 200 and 1,000 meters (660 and 3,300 feet) deep.

Mesophyte — A plant that grows under medium or usual conditions of atmospheric moisture supply, as distinguished from one

- which grows under dry or desert conditions (*Xerophyte*) or very wet conditions (*Hydrophyte*).
- Mesosaline** — Term to characterize waters with salinity of 5 to 18‰ (parts per thousand), due to land-derived salts.
- Mesosere** — (Ecology) A community of plants that appears temporarily in an environment when there is a moderate amount of moisture in the soil.
- Mesosphere** — The division of the *Atmosphere* above the *Stratosphere*. The mesosphere begins about 50 kilometers (31 miles) in altitude and extends to about 80 kilometers (50 miles).
- Mesothermal** — Applied to hydrothermal deposits formed at intermediate temperature and intermediate pressure.
- Mesotrophic** — (Ecology) Of a lake or other body of fresh water, having an intermediate amount of plant nutrients and therefore moderately productive.
- Mesotrophic (Water)** — (1) Reservoirs and lakes which contain moderate quantities of nutrients and are moderately productive in terms of aquatic animal and plant life. (2) Pertaining to a lake or other body of water characterized by moderate nutrient concentrations such as nitrogen and phosphorous and resulting significant productivity. Such waters are often shallow, with algal blooms and periods of oxygen deficiency. Slightly or moderately eutrophic water can be healthful and support a complex web of plant and animal life. However, such waters are generally undesirable for drinking water and other needs. Degrees of *Eutrophication* typically range from *Oligotrophic* water (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hypereutrophic* water (minimum transparency, maximum chlorophyll-a, maximum phosphorus). Also see *Carlson's Trophic State Index (TSI)* and *(Mean) Trophic State Index (TSI)*.
- Meta- or Met- (Prefix)** — Derived from by loss of water, as meta phosphoric acid.
- Metabiosis** — A mode of living in which one organism is dependent on another for preparation of an environment in which it can live.
- Metabolism** — (Biology) (1) The sum of the chemical reactions occurring within a cell or a whole organism; includes the energy-releasing breakdown of molecules (catabolism) and the synthesis of new molecules (anabolism). (2) The sum of the processes concerned in the building up of protoplasm and its destruction incidental to life; the chemical changes in living cells, by which the energy is provided for the vital processes and activities, and new material is assimilated to repair the waste. Metabolism may be considered as including two aspects or processes: constructive metabolism (termed *Anabolism* or *Assimilation*) or destructive metabolism (termed *Catabolism* or *Dissimilation*). Anabolism and Catabolism go on together, but one may predominate and obscure the other. Also see *Zone of Net Metabolic Production*.
- Metalimnion** — The middle layer of a *Thermally Stratified Lake* or reservoir. In this layer there is a rapid decrease in temperature with depth. Also referred to as *Thermocline*.
- Metamorphic Rock** — (Geology) (1) A sedimentary or igneous rock that has been changed by pressure, heat, or chemical action. For example, limestone, a sedimentary rock, is converted to marble, a metamorphic rock. (2) Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the Earth's crust.
- Metamorphism** — A change in the constitution of rock; specifically a pronounced change effected by pressure, heat, and water that results in a more compact and more highly crystalline condition.
- Meteoric Water** — (1) Groundwater derived primarily from precipitation and the atmosphere. (2) Water derived from rain, water courses, and other bodies of water. Water in or derived from the atmosphere.
- Meteorological Drought** — A drought said to occur when annual rainfall (or precipitation) is less than the long-term average annual rainfall. Compare to *Hydrological Drought* and *Agricultural Drought*.
- Meteorological Tide** — (Oceanography) A change in water level caused by meteorological factors, such as barometric pressure and wind.
- Meteorology** — The science that deals with the phenomenon of the atmosphere, especially weather and weather conditions.
- Meter** — A unit of length which constitutes the basis of the *Metric System*, was intended to be, and is very nearly, one ten-millionth part of the distance measured on a meridian of the earth from the equator to the pole, being equal to 39.37 U.S. inches or about 3 feet 3-3/8 inches. See *Metric System*.
- Methane** — A colorless, nonpoisonous, flammable gas, CH₄, created by *Anaerobic* decomposition of organic compounds. An odorless, flammable gas that is the major constituent of natural gas; the simplest member of the paraffin series.
- Methemoglobinemia** — A blood disorder that impairs the ability of the blood supply to carry oxygen throughout the body. Also known as "blue baby syndrome", it is frequently caused by high concentrations of nitrate in drinking water supplies. It primarily affects infants less than 6 months of age. Most instances of the problem can be traced to babies drinking milk formula mixed in water with very high nitrate levels.
- Method Blank** — Laboratory grade water taken through the entire analytical procedure to determine if samples are being accidentally contaminated by chemicals in the lab.
- Method Detection Limit (MDL)** — The contaminant concentration that when processed through complete analytical method, produces a signal 99 percent probability that is different from the *Blank*.
- Methoxychlor** — A pesticide which causes adverse health effects in domestic water supplies and is also toxic to freshwater and marine aquatic life. The chemical name for methoxychlor is 2,2-bis (P-methoxyphenol)-1, 1, 1 - trichloroethane.
- Methyl Mercury** — A highly toxic form of mercury found in the environment; CH₃-Hg. Mercury deposited in the environment may be converted to methyl mercury by microorganisms or chemical processes. Methyl mercury is very toxic and can accumulate in the tissues of animals including fish, eagles, and humans.
- Methyl Orange Alkalinity** — A measure of the total alkalinity in a water sample. The alkalinity is measured by the amount of standard sulfuric acid required to lower the pH of the water to a pH level of 4.5, as indicated by the change in color of methyl orange from orange to pink. Methyl orange alkalinity is expressed as milligrams per liter equivalent calcium carbonate.

Methyl Tertiary Butyl Ether (MTBE) — A oxygenate and gasoline additive used to improve the efficiency of combustion engines in order to enhance air quality and meet air pollution standards. MTBE is a product of petroleum refining that has been added to gasoline nationwide since the late 1970's as an octane booster. Following federal actions in the early 1990's, refiners began adding more MTBE to clean up the air. Current federal law requires some minimum amount of an oxygenate in gasoline sold in areas that do not meet air quality standards. The *U.S. Environmental Protection Agency (EPA)* considers MTBE a possible human carcinogen. In addition to being a suspected carcinogen, MTBE also pollutes waters, particularly by personal watercraft using two-stroke marine engines. More recently, leaking gasoline storage tanks containing MTBE have been found to cause contamination of nearby municipal water wells forcing their closure. MTBE has been found to mix and move more easily in water than many other fuel components, thereby making it harder to control, particularly once it has entered surface or groundwaters.

Methylcellulose — Any of various gummy products of cellulose methylation that swell in water and are used especially as emulsifiers, adhesives, thickeners, and bulk laxatives.

Methylene Blue — A basic aniline dye, $C_{16}H_{18}N_3SCl \cdot 3H_2O$, that forms a deep blue solution when dissolved in water. It is used as an antidote for cyanide poisoning and as a bacteriological stain.

Methylene Blue Active Substances — See *MBAS*.

Methylmercury — An organic compound that has known neurological toxicity effects that tend to biomagnify up the food chain in aquatic environments.. Biomagnification is a biological process wherein a contaminant's concentration increases at each level up the food chain, including humans. Thus, the availability of such contaminants, even in the seemingly insignificant parts per trillion range, often are ecologically important. Typically, methylmercury is formed by the action of certain bacteria on available supplies of inorganic mercury in stream-bottom sediments containing low concentrations of dissolved oxygen. However, the reverse process, or demethylation also is known to occur and this "detoxifying" of methylmercury is the subject of ongoing research.

Metric System — A decimal system of measures and weights with the meter and the gram as bases. The units of the metric system at the outset were all derived from the unit of length, the *Meter*, which was intended to be, and is very nearly, one ten-millionth part of the distance measured on a meridian of the earth from the equator to the pole, being equal to 39.37 U.S. inches or about 3 feet 3-3/8 inches. Upon the meter were originally based the other primary units of measure: the square meter (area), the cubic meter (volume), the *Liter* (liquid volume), and the *Gram* (mass and weight). It was found, however, that masses could be compared with a higher degree of accuracy than that with which volumes could be determined, and it was therefore preferable to have a material standard of mass specifically defined rather than one derived from the unit of length through the unit of volume. A definite mass, the *International Prototype Kilogram* was, therefore, adopted as the standard of mass, and the unit of volume, the liter, was then redefined in terms of the standard of mass; the liter being defined as the volume of a kilogram of pure water at the temperature of its maximum density (4EC or 39.2EF), and equal to 1.000027 cubic decimeters. Also see *Avoirdupois Weight*. Presented below are metric equivalent tables related to length, area, volume, and weight.

[1] Standard Metric Table – Length		
Name	Metric Length Measure	United States Measure
Myriameter	10,000 meters	6.2137 miles
Kilometer	1,000 meters	0.62137 miles
Hectometer	100 meters	328 feet and 1 inch
Decameter	10 meters	39.37 inches
Meter	1 meter	39.37 inches
Decimeter	0.1 meter	3.937 inches
Centimeter	0.01 meter	0.3937 inches
Millimeter	0.001 meter	0.03937 inches

[2] Standard Metric Table – Area		
Name	Metric Length Measure	United States Measure
Hectare	10,000 square meters	2.471 acres
Are	100 square meters	119.6 square yards
Centiare	1 square meter	1,550. square inches

[3] Standard Metric Table – Volume				
Name	Liter Equivalent	Metric Cubic Measure	United States Measure	British Measure
Kiloliter	1,000	1 cubic meter	1.308 cubic yard	1.308 cubic yard
Hectoliter	100	0.1 cubic meter	2.838 bu./26.418 gal	2.75 bu./22.00 gal
Decaliter	10	10 cubic dm.	1.135 pk./2.6418 gal	8.80 qt./2.200 gal

Liter	1	1 cubic dm.	0.9081 qt./1.0567 liq qt.	0.880 quarts
Deciliter	0.1	0.1 cubic dm.	6.1025 cu. in./0.845 gill.	0.704 gill.
Centiliter	0.01	10 cubic cm.	0.6102 cu. in./0.338 fl. oz.	0.352 fl. oz.
Milliliter	0.001	1 cubic cm.	0.061 cu. in./0.27 fl. dram	0.28 fl. dram.

Volume Table Notes:
 dm. = decimeter = 1/10 meter
 cm. = centimeter = 1/100 meter
 bu. = bushel = 4 pecks = 32 quarts
 pk. = peck = 1/4 bushel = 8 quarts
 qt. = quart = 2 pints = 1/4 gallons
 liq qt. = liquid quart = 1.1635 (dry) quarts
 gill = 1/4 pint
 fl. dram = fluid dram = 1/16 ounce = 27.34375 grains = 1.772 grams

[4] Standard Metric Table – Weight			
Name	Number of Grams	Comparable Quantity of Water at Maximum Density	Avoirdupois Weight
Metric Ton	1,000,000	1 cubic meter	2204.6 lb.
Quintal	100,000	1 hectoliter	220.46 lb.
Myriagram	10,000	1 decaliter	22.046 lb.
Kilogram	1,000	1 liter	2.2046 lb.
Hectogram	100	1 deciliter	3.5274 oz.
Decagram	10	10 cubic centimeters	0.3527 oz.
Gram	1	1 cubic centimeter	15.432 grains
Decigram	0.1	0.1 cubic centimeter	1.5432 grains
Centigram	0.01	10 cubic millimeters	0.1543 grains
Milligram	0.001	1 cubic millimeter	0.0154 grains

Metrics — A general term used to describe the quantifying of actions and reactions, processes and outcomes, and systems and results to provide a measurable means of performance, productivity, efficiency, etc.

MF — Membrane Filter.

MGD — Million gallons per day. A unit of water usage used in many applications of water and wastewater treatment processes.

MG/L (µg/L) — Stands for “micrograms per liter.” This is a common unit of chemical concentration in a solution. It expresses the mass of a chemical that is present in a given volume of water. A milligram is one one-millionth (1/1,000,000) of a gram. A liter is a measure of volume equivalent to about one quart. Another term used as an equivalent measure to µg/L is *Parts per Billion (ppb)*.

MG/L (mg/L) — Stands for “milligrams per liter.” This is a common unit of chemical concentration in a solution. It expresses the mass of a chemical that is present in a given volume of water. A milligram is one one-thousandth (1/1,000) of a gram. A liter is equivalent to about one quart. Another term used as an equivalent measure to mg/L is *Parts per Million (ppm)*.

Microbe — Short for *Microorganism*. (1) Briefly, any minute, simple, single-celled form of life, especially one that causes disease. (2) Small organisms that can be seen only with the aid of a microscope. The term encompasses viruses, bacteria, yeast, molds, protozoa, and small algae; however, microbe is used most frequently to refer to bacteria. Microbes are important in the degradation and decomposition of organic materials added to the environment by natural and artificial mechanisms. Also referred to as *Germ*s.

Microbial Growth — The activity and growth of microorganisms such as bacteria, algae, diatoms, plankton, and fungi.

Microbial Load — The total number of bacteria and fungi in a given quantity of water or soil or on the surface of food. The presence of the bacteria and fungi may not be related to the presence of disease-causing organisms.

Microbiological Anaerobic Degradation — The use of *Microbes*, either already present at a site or introduced for a specific treatment process, to degrade and render harmless hazardous wastes and toxic compounds in soil and water. Under such conditions, the microbes are used to break down organic compounds in contaminated soil and groundwater in an environment of little or no oxygen. Also see *Attenuation* and *Natural Attenuation*.

Microbiological Contaminants — Microbiological organisms that were the first drinking water contaminants to arouse concern. The first federal standards to control these “microbials” in drinking water date back to 1914. Cholera has been under control in this country since the 1870’s and typhoid since about 1910.

Microbiological Tuberculation — (Water Quality) A condition in older water distribution pipes characterized by reddish brown mounds of various heights attached to the interior of the pipe wall. These mounds are the result of many years of iron and manganese bacterial growth that deposit iron and/or manganese oxides along with particulate matter from the water trapped in the biomass from generations of bacteria. An aging distribution system experiencing this problem is typically characterized by

red water, taste and odor problems, turbidity, reduced pressure and flow rates, and a low chlorine residual. Iron bacteria are very common in all water sources with over twenty different iron bacteria that can cause tuberculation. They are generally considered to be non-pathogenic. Tuberculation usually begins with a slime that may show signs of iron oxide precipitation. The iron bacteria, which attach themselves to the interior surface of the pipe, metabolize ferrous ions from the water as an energy source, precipitating ferrous oxide which becomes trapped in the biomass of the tuberculation. In the past, tuberculation usually resulted in replacement of the water distribution pipe; however, more recently, chemical treatments of isolated sections of pipeline have proven both highly effective and less costly. Also referred to as *Tuberculation*.

Microbiology — The study of organisms that can be seen only with the aid of a microscope. The science deals with the structure and chemical composition of various *Microbes*, the biochemical changes within the environment that are caused by members of this group, the diseases caused by microbes, and the reaction of animals, including humans, to their presence.

Microbiota — The plants, animals, and microorganisms that can only be seen with the aid of a microscope.

Microclimate — (1) The local climate conditions, brought about by the modification of general climatic conditions by local differences in elevation and exposure. The detailed climate of a very small area of the earth's surface. (2) Also, the localized climate conditions within an urban area or neighborhood.

Microclimatology — The study of local climatic conditions, especially the analysis of climatic profiles of the lowest stratum of the atmosphere.

Microcosm — A laboratory model of a natural *Ecosystem* in which certain environmental variables can be manipulated to observe the response. The model test results are not always applicable to an actual ecosystem because the microcosm is, of necessity, a simplified collection of selected physical, chemical, and biological ecosystem components.

Microfauna — Animals invisible to the naked eye, such as copepods and mites.

Microfiltration — (Water Treatment) (1) A physical separation process where tiny, hollow filaments members separate particles from water. With further research, it may eventually be used as a pre-treatment for *Reverse Osmosis*. (2) Similar to reverse osmosis, the microfiltration process utilizes filtering membranes with larger-sized pores to remove suspended particles from water. This water filtration technique provides an economical and practical treatment process for smaller-sized water systems. Unlike other treatment processes, microfiltration relies on mechanical retention instead of chemical treatment and so long as the pore size of the membranes is smaller than the contaminant to be filtered, the constituent will not pass through.

Microflora — Plants invisible to the naked eye, such as diatoms and algae.

Microgram — One-millionth of a gram (3.5×10^{-8} ounces, i.e., 0.000000035 ounces).

Micrograms per Deciliter ($\mu\text{g/dL}$) — Micrograms per deciliter.

Micrograms per Gram ($\mu\text{g/g}$) — A unit expressing the concentration of a chemical constituent as the mass (micrograms) of the element per unit mass (gram) of material analyzed.

Micrograms per Kilogram ($\mu\text{g/kg}$) — A unit expressing the concentration of a chemical constituent as the mass (micrograms) of the element per unit mass (kilogram) of material analyzed. One microgram per kilogram is equivalent to 1 part per billion.

Micrograms per Liter ($\mu\text{g/l}$) — A unit expressing the concentration of a chemical constituents in water as the mass (micrograms) of the element per unit volume (liter) of material analyzed. One thousand micrograms per liter is equivalent to one *Milligram per Liter (mg/l)*. This measure is also equivalent to *Parts Per Billion (PPB)*.

Microlayer — (Oceanography) Specifically, the thin layer just beneath the surface of the water, within which there is interaction between the water and the air.

Micromho — A unit of electrical conductance. Specifically, one-millionth the conductance of a body through which one ampere will flow when the potential difference is one volt.

Micron (μ) — A unit of length equivalent to a micro-meter (μm), or one-millionth of a meter (10^{-6} meter). One micron equals 0.00004 of an inch. Micro-meter is the preferred term.

Micronutrient — A chemical element required only in small amounts (usually less than one part per million [ppm] in the plant) for the growth of plants.

Microorganisms — Very small animals and plants that are too small to be seen by the naked eye and must be observed using a microscope. Microorganisms in water include algae, bacteria, viruses, and protozoa. Algae growing in surface waters can cause off-taste and odor by producing the chemicals MIB and geosmin. Certain types of bacteria, viruses, and protozoa can cause disease in humans. Bacteria are the most common microorganisms found in treated drinking water. The great majority of bacteria are not harmful. In fact, humans would not be able to live without the bacteria that inhabit the intestines. However, certain types of bacteria called coliform bacteria can signal the presence of possible drinking water contamination.

Micropore — (Geology) A *Pore* that is small enough to hold water against the pull of gravity in addition to inhibiting water flow.

Microscopic Particulate Analysis (MPA) — (Water Quality) A process used to assess water treatment plant performance. This form of analysis compares type, size, and quantities of *Bioindicators*, or microbiota (1–600 μm) in particles found in *Raw Water* to those found in the *Finished Water*. This method is particularly effective in evaluating filtration efficiencies, as log reduction, of conventional treatment systems, as well as for on-site evaluation of alternate filtration technologies.

Microsiemens per Centimeter ($\mu\text{S/cm}$) — A unit expressing the amount of electrical conductivity of a solution as measured between opposite faces of a centimeter cube of solution at a specified temperature. Siemens is the International System of Units nomenclature. It is synonymous with mhos and is the reciprocal of resistance measured in ohms.

Microsystem Irrigation — Method of precisely applying irrigation water to the immediate root zone of the target plant at very low rates.

Microwave Oven — An oven in which food is cooked by the heat produced by the absorption of microwave energy by water molecules in the food.

Mid-Seral Condition — Synonymous with fair ecological conditions.

Midstream — The middle part of a stream.

Midwater — (Oceanography) The ocean beneath the surface layers but above the *Benthic Zone*.

Migration — (1) The movement of oil, gas, contaminants, water, or other liquids through porous and permeable rock. (2) The gradual shifting downstream of a *Meander* system, including the enlargement of the curves and the widening of the course.

Mil — A unit of length equal to 0.001 of an inch. The diameter of wires and tubing is measured in mils, as is the thickness of plastic sheeting.

Milldam — A dam constructed across a stream to raise the water level so that the overflow will have sufficient power to turn a mill wheel.

Milliequivalents per Liter (MEQ/L) — An expression of the concentration of a material dissolved in water, calculated by dividing the concentration, in milligrams per liter, by the *Equivalent Weight* of the dissolved material. For example, the equivalent weight of aluminum is 9.0. A water concentration of aluminum of 1.8 milligrams per liter equals an aluminum concentration of 0.2 milliequivalent per liter.

Milligram (MG) — One-thousandth of a gram.

Milligrams per Liter (mg/L) — (1) A measure of concentration of a dissolved substance. A concentration of one mg/L means that one milligram of a substance is dissolved in each liter of water. For practical purposes, this unit is equal to parts per million (ppm) since one liter of water is equal in weight to one million milligrams. Thus, a liter of water containing 10 milligrams of calcium has 10 parts of calcium per one million parts of water, or 10 parts per million (10 ppm). (2) A unit of the concentration of a constituent in water or wastewater and expresses the concentration of chemical constituents in water as the mass (milligrams) of constituent per unit volume (liter) of water. Concentration of suspended sediment also is expressed in mg/l and is based on the mass of dry sediment per liter of water-sediment mixture. It represents 0.001 gram of a constituent in 1.000 milliliter (ml) of water. It is approximately equal to one part per million (PPM). The term milligram per liter has replaced parts per million in water quality management.

Milliliter — A milliliter is one-thousandth (1/1,000) of a liter. A liter is a measure of volume equivalent to a little more than a quart. A milliliter is about two drops from an eyedropper.

Millimicron — A unit of length equal to 10^{-3} microns (one thousandth of a micron), 10^{-6} millimeters, or 10^{-9} meters; correctly called a manometer.

Million Gallons per Day (MGD) — (1) A measure of water flow. (2) A rate of flow of water equal to 133,680.56 cubic feet (cf) per day, or 1.5472 cubic feet per second (cfs), or 3.0689 acre-feet per day. A flow of one million gallons per day (mgd) for one year equals 1,120 acre-feet (365 million gallons).

Millipore Filter — A thin membrane of modified cellulose that is used as a filter in the bacteriological examination of water or wastewater. The filter is typically used to filter a given quantity of aqueous sample followed by transfer of the filter to the surface of a special medium to allow for the growth of the bacteria that have been retained by the filter. At one time the only commercial source of these filters was the Millipore Corporation, although presently a variety of sources are now available. Even so, the common name Millipore filter has been retained.

Millpond — A pond created by damming a stream to produce a head of water for operating a mill.

Millrace — (1) The fast-moving stream of water that drives a mill wheel. (2) The channel for the water that drives a mill wheel. Also referred to as *Millrun*.

Millstream — The rapid stream of water flowing in a *Millrace*.

Mill Wheel — A wheel, typically driven by water, that powers a mill.

Mine Drainage — Water pumped or flowing from a mine.

Mineral — (1) Any naturally occurring inorganic material with an orderly internal arrangement of atoms and specific physical and chemical properties. (2) An inorganic substance occurring in nature, which has a definite or characteristic chemical composition and molecular structure and distinctive physical properties.

Mineral Resource — Known mineral deposits of an area which have present or future utility.

Mineral Soil — Soil composed of predominantly mineral rather than organic materials.

Mineral Spring — A spring containing enough dissolved mineral salts to give its water a distinguishable taste.

Mineral Water — (1) Water that contains a high quantity of dissolved mineral salts or gases, especially such water that is considered healthful to drink. (2) Naturally occurring or prepared water that contains dissolved mineral salts, elements, or gases, often used therapeutically. Also see *Bottled Water [General]*, *Bottled Water [Food and Drug Administration]*, and *Bottled Water [Nevada]*.

Mineralization — (1) The microbial conversion of an element from an organic to an inorganic state. (2) The general process by which elements present in organic compounds are eventually converted into inorganic forms, ultimately to become available for a new cycle of plant growth. (3) The process whereby concentrations of minerals, such as salts, increase in water, often as a natural process resulting from water dissolving minerals found in rocks and soils through which it flows.

Mineralogy — The science and study of minerals.

Miner's Inch [Western United States] — The rate of discharge through an orifice one inch square under a specific head. An old term used in the western United States, now seldom used except where irrigation or mining water rights are so specified. The equivalent flow in cubic feet per second is fixed by state statute. One miner's inch is equivalent to 0.025 cubic foot per second (1.5 cubic feet per minute, equivalent to one-fortieth of a second-foot) in Arizona, California, Montana, Nevada, and Oregon; 0.020 cubic foot per second in Idaho, Kansas, Nebraska, New Mexico, North and South Dakota, and Utah; 0.026 cubic foot per second in Colorado; and 0.028 cubic foot per second in British Columbia.

Miner's Inch [Nevada] — Defined as a rate of flow or discharge equivalent to 1/40 of 1 (0.025) cubic foot per second (cfs).

Mine Wash — Water-deposited accumulation of sandy, silty, or clayey material recently eroded in mining operations.

Minim — A unit of fluid measure, in the United States equal to 1/60 of a fluid dram (0.0616 milliliters, or 0.00208 fluid ounces), and

in Great Britain equal to 1/20 of a scruple (0.0592 milliliters or 0.00200 fluid ounces).

Minimal Flood Hazard Areas — Areas between the 100-year and the 500-year flood boundaries are termed *Moderate Flood Hazard Areas*. The remaining areas are above the 500-year flood level and are termed *Minimal Flood Hazard Areas*.

Minimum Flow Appropriation — An appropriation designed to preserve a specified minimum flow in a stream. When the flow in the stream drops to that which is specified in the appropriation, junior appropriations will be required to stop diverting water in order to maintain the minimum flow. See *(Prior) Appropriation Doctrine*.

Minimum Instream Flow (Streamflow) — The specific amount of water required to support aquatic life, to minimize pollution, or for recreation. It is subject to the priority system and does not affect water rights established prior to its institution. Also referred to as *Minimum Instream Flow*.

Minimum Moisture Content — The amount of water in soil during the driest time of the year.

Minimum Pool — A term used to describe the lowest level of reservoir capacity safe for maintaining fish and aquatic life or for some other designated beneficial purpose. This term differs from *Dead Storage Capacity* in that the reservoir level may still be reduced below minimum pool, whereas the dead storage capacity represents a level below the lowest outlet level.

Minimum Streamflow — See *Minimum Instream Flow*.

Minimum Thermometer — An instrument with an index which remains at the lowest temperature occurring since its last setting.

Minimum Tillage Farming — A farming technique that reduces the degree of soil disruption. Crop residues are not plowed under after harvest, and special planters dig narrow furrows in the crop residue when new seeds are sown. Advantages of the technique include reductions in energy consumption by farm equipment, less soil erosion, and lower soil moisture losses during the fallow season. Disadvantages include the possibility of encouraging insect pests by leaving the crop residue in the field and the use of herbicides to control weeds in the place of mechanical cultivation. Sometimes incorrectly termed *No-Till Farming*.

Mining (of an Aquifer) — Withdrawal over a period of time of groundwater that exceeds the rate of recharge of the aquifer.

Mining Water Use — Water use for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, well operations (*Dewatering*), milling (crushing, screening, washing, flotation, and so forth), and other preparations customarily done at the mine site or as part of a mining activity, such as dust control, maintenance, and wetland restoration. Generally, most of the water used at a mining operation is self-supplied. Also see *Self-Supplied Water*.

Minor Flooding — Flooding resulting in minimal or no property damage but some public inconvenience. Also referred to as *Nuisance Flooding*. Also see *Major Flooding* and *Moderate Flooding*.

Minors — *Publicly Owned Treatment Works (POTWs)* with flows of less than 1 million gallons per day. Contrast with *Majors*.

Mirage — An optical phenomenon that creates the illusion of water, often with inverted reflections of distant objects, and results from distortion of light by alternate layers of hot and cool air. Also referred to as *Fata Morgana*.

Mire — (1) An area of wet, soggy, muddy ground; a bog. (2) Deep, slimy soil or mud. (3) (Geology) Wet, spongy earth. A small area of marshy, swampy, or boggy ground.

Miscellaneous Site (Station) — (USGS) A site where streamflow, sediment, and/or water-quality data are collected once, or more often on a random or discontinuous basis.

Miscible (Liquids) — Liquids which are soluble in each other.

Miscible Displacement — Mutual mixing and movement of two fluids that are soluble in each other. Synonymous with *Miscible-Phase Displacement*.

Misfit Stream — A stream whose size is not in proportion to the area in which it is found, especially a stream that appears too small to have eroded the valley in which it flows.

Mismatch — A condition in which water supplied to a given point in a conveyance or distribution system does not equal the demand for water at that point.

Missed Detection — (Water Quality) The situation that occurs when a test indicates that a tank is “tight” when in fact it is leaking.

Mist — (1) A mass of fine droplets of water in the atmosphere near or in contact with the earth; liquid particles measuring 40 to 500 microns, formed by condensation of vapor. By comparison, fog particles are smaller than 40 microns. (2) Water vapor condensed on and clouding the appearance of a surface.

Mitigation — (1) (Environmental, General) Actions designed to lessen or reduce adverse impacts; frequently used in the context of environmental assessment. (2) (NEPA) Action taken to avoid, reduce the severity of, or eliminate an adverse impact. Mitigation can include one or more of the following:

- [1] avoiding impacts;
- [2] minimizing impacts by limiting the degree or magnitude of an action;
- [3] rectifying impacts by restoring, rehabilitating, or repairing the affected environment;
- [4] reducing or eliminating impacts over time; and
- [5] compensating for the impact by replacing or providing substitute resources or environments to offset the loss.

Mixed Current — (Oceanography) A current associated with a marked difference in speed and duration between the two successive ebb or flood currents of a *Tidal Day*.

Mixed Liquor — (Water Quality) In wastewater treatment, the liquid in the aeration tank of an activated sludge system; a mixture of activated sludge and water containing organic matter undergoing activated sludge treatment in an aeration tank.

Mixed Liquor Suspended Solids (MLSS) — The quantity of suspended solids in the aeration tank of an activated sludge. Reported in units of milligrams per liter (mg/l).

Mixed Liquor Volatile Suspended Solids (MLVSS) — That portion of *Mixed Liquor Suspended Solids (MLSS)* that will vaporize when heated to 600EC (1,112EF). This volatile fraction is mainly organic material and thus indicates the biomass present in the

aeration tank. The material that does not vaporize in this test, mostly inorganic substances, is said to be fixed.

Mixed Media Filtration — A system using two or more dissimilar granular materials (such as anthracite, sand and garnet) blended by size and density. Such a filter is graded from coarse to fine in the direction of flow.

Mixed Water — (Volcanology) A combination of *Volcanic Water* and atmospheric water.

Mixohaline — Term to characterize water with salinity of 0.5 to 30‰ (parts per thousand), due to ocean salts. The term is roughly equivalent to the term brackish.

Mixosaline — Term to characterize water with salinity of 0.5 to 30‰ (parts per thousand), due to land-derived salts.

Mixolimnion — (1) The uppermost region in a *Meromictic Lake*. (2) In a meromictic lake, the low-density, freely circulating upper layer.

Mizzle — To rain in fine, mist-like droplets; to drizzle. Also, a mist-like rain, a drizzle.

Moapa National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Moapa NWR was established in 1979 in order to protect and secure habitat for the Endangered Moapa dace and a candidate for listing, the White River springfish. The refuge contains 32 acres (0.05 square mile) and is located just north of the Moapa River Indian Reservation, 5 miles northwest of Moapa, Nevada, located in Clark County. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Moat — (1) A deep, wide ditch, usually filled with water, typically surrounding a fortified medieval town, fortress, or castle as a protection against assault. (2) A deep glacial trench or a channel at the margin of a dwindling glacier that resembles a moat. Also see *Oxbow Lake*. (3) (Geology) A continuous or discontinuous ringlike depression around the base of many seamounts. Also referred to as a *Sea Moat*.

Mobile Belts — An elongated zone of the earth's crust subjected to relatively great structural deformation.

Mode — (Statistics) In a set of observations, the most frequently occurring value. Also see *Mean* and *Median*.

Model — (1) (General) An idealized representation of reality developed to describe, analyze, or understand the behavior of some aspect of it. (2) (Mathematical and Statistical) A simulation, by descriptive, conceptual, statistical, or other means, of a process or thing that is difficult or impossible to observe directly, as in an *Economic Consumption Model* or a *River Flow Model*. A descriptive or conceptual model is one which represents the structure or mechanisms of a model but does not specify the relationships in numerical form. The concept of a (simulation) quantitative model is to approximate reality by means of a quantifiable process such as a mathematical equation or series of equations. In this way the model may be used to simulate various changes in conditions in a "what if" or predictive framework. The fundamental premise of model building is that within some defined bounds of statistical probability a model may be constructed based upon the past behavior of some numeric quantity or variable, or a set of such variables, so as to be able to predict the future behavior of that variable. The actual structure of the model represents the underlying set of assumptions about a phenomenon based on the model builder's view of reality, theoretical underpinnings, proven or probable causal relationships, and deductions and inferences from past observations and experience. To be manageable and useful as a predictive tool, the model must sufficiently simplify the complexities of reality so as to lend itself to some quantifiable structure. However, this simplifying process must not be so extensive as to weaken the model's validity and negate its usefulness as an explanatory and predictive tool.

(Econometric) Model Building — (Statistical Analysis and Forecasting) An iterative process for developing a model beginning with some information about the form and structure of the problem and with relevant data. The model building process typically follows a sequence of inter-related steps to include:

- [1] **Problem Identification and Data Selection** — Data is selected, compilation, screened, and analyzed, and the various series tested based on hypotheses of probable causation;
- [2] **Model Identification (or Specification)** — Selection of a general model structure is made based on the nature of the data and the types of outputs desired. Some of these include, for example, a simple single mathematical equation, or multiple (sequential) equations, statistically-based univariate (deterministic) autoregressive functions, multivariate analysis, simple ordinary least squares (OLS) regression, multiple regression, simultaneous equation, etc.;
- [3] **Estimation (Model Fitting)** — Based on the selection of a model structure, the data is used to best describe the behavior of the variable under observation, e.g., stream flows, reservoir levels, runoff, economic output, employment, consumer spending, etc.;
- [4] **Model Testing (and Refinement, as Necessary)** — The model's structure and variables chosen are then validated by applying the data and observing forecast errors with respect to known (sample) values;
- [5] **Forecasting** — Based upon the ability of the model to accurately "fit" or predict historical values, the model is used to forecast beyond the last data point as prescribed by scenarios under analysis.

Model Plant — A hypothetical plant design used for developing economic, environmental, and energy impact analyses as support for regulations or regulatory guidelines; the first step in exploring the economic impact of potential *New Source Performance Standards (NSPS)*.

Modeling (Forecasting and Simulation Analysis) — (1) Use of mathematical equations to simulate and predict real events and processes. (2) The application of a mathematical process or simulation framework, for example a mathematical or *Econometric Model*, to describe various phenomenon and analyze the effects of changes in independent (i.e., explanatory) variables on dependent variables.

Moderate Flood Hazard Areas — Areas between the 100-year and the 500-year flood boundaries are termed *Moderate Flood Hazard Areas*. The remaining areas are above the 500-year flood level and are termed *Minimal Flood Hazard Areas*.

Moderate Flooding — Flood conditions characterized by the inundation of secondary roads, transfer of property to higher elevations, and some evacuations of people and livestock. Also see *Major Flooding* and *Minor Flooding*.

Moderator — (Physics) A substance, such as water or graphite, that is used in a nuclear reactor to regulate the speed of fast neutrons and alter the likelihood of fission.

Moho — The boundary surface or sharp seismic velocity discontinuity that separates the Earth's crust from the underlying mantle.

Moisture — (1) Diffuse wetness that can be felt as vapor in the atmosphere or condensed liquid on the surface of objects; dampness. (2) The state or quality of being damp.

Moisture Advection — The transport of moisture by horizontal winds.

Moisture Convergence — A measure of the degree to which moist air is converging into a given area taking into account the effect of converging wind and moisture advection. Areas of persistent moisture convergence are favored regions for thunderstorm development if other factors are favorable.

Moisture Equivalent — The ratio of: (1) the weight of water which the soil, after saturation, will retain against a centrifugal force 1,000 times the force of gravity, to (2) the weight of the soil when dry. The ratio is stated as a percentage.

Moisture Stress — A condition of physiological stress in a plant caused by a lack of water.

Moisture Tension — The equivalent negative pressure in the soil water. It is equal to the equivalent pressure that must be applied to the soil water to bring it to hydraulic equilibrium, through a porous permeable wall or membrane, with a pool of water of the same composition.

Molar or Molarity — (1) A solution containing the indicated number of *Moles* of solute per liter of solution. (2) A molar solution consists of one gram molecular weight of a compound dissolved in enough water to make one liter of solution. A gram molecular weight is the molecular weight of a compound in grains. For example, the molecular weight of sulfuric acid (H_2SO_4) is 98. A one M solution of sulfuric acid would consist of 98 grains of H_2SO_4 dissolved in enough distilled water to make one liter of solution.

Mole — (Chemistry) (1) The molecular weight of a substance, usually expressed in grains. (2) The mass of a compound in grams numerically equal to its molecular weight. Also, the mass of a compound containing Avogadro's number of molecules.

Molecular Diffusion — (1) Dispersion of a chemical caused by the kinetic activity of the ionic or molecular constituents. (2) The process in which solutes are transported at the microscopic level due to variations in the solute concentrations within the fluid phases. Also see the *Coefficient of Molecular Diffusion*.

Molecular Weight — The sum of the atomic weights of the atoms in a molecule. For example, the molecular weight of water (H_2O) is 18, which is equivalent to the sum of the atomic weights of two hydrogen atoms ($1+1=2$) and oxygen (16). Similarly, the molecular weight of sulfuric acid (H_2SO_4) in grams is 98.

Molecule — (1) A group of atoms held together by chemical bonds. They may be either atoms of a single element (O_2) or atoms of different elements that form a compound (H_2O). (2) The smallest amount of a compound which has all the properties of the compound. (3) The smallest division of a compound that still retains or exhibits all the properties of the substance. H_2O is the molecular symbol for water, indicating two atoms of hydrogen (H_2) combined with one atom of oxygen (O). (4) A stable configuration of atomic nuclei and electrons bound together by electrostatic and electromagnetic forces. It is the simplest structural unit that displays the characteristic physical and chemical properties of a compound.

Momentum Coefficient — See *Boussinesq Coefficient*.

Monimolimnion — (1) The lower region in a *Meromictic Lake*. (2) The high-density, stable, stagnant or non-circulating lower layer of a meromictic lake.

Monitor — An articulated device holding a rotating nozzle with which a jet of water is regulated, used in mining and fire fighting.

Monitored Natural Attenuation [EPA] — Refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a timeframe that is reasonable compared to that offered by other more active methods. The natural attenuation processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contaminants in soil or groundwater.

Monitoring — (1) Measuring concentrations of substances in environmental media or in human or other biological tissues. (2) Sampling and analysis of air, water, soil, wildlife, and other conditions, to determine the concentrations of contaminants. (3) (Ecology) The component of *Adaptive Management* in which information is collected to track system behavior and its response to management.

Monitoring Well — (1) A well used to obtain water quality samples or measure groundwater levels. Wells used to collect groundwater samples for analysis to determine the amount, type, and spread of contaminants in groundwater. (2) (Water Quality) A well drilled in close proximity to a waste storage or disposal facility, or hazardous waste management facility or *Superfund Site* to check the integrity of the facility or to keep track of leakage of materials into the adjacent groundwater. Also referred to as an *Observation Well*.

Mono Lake [California] — Mono Lake and its surrounding watershed encompass a unique region in the State of California's portion of the western *Great Basin*. Mono Lake's recent (1999) surface elevation was 6383.8 feet (1,946 meters) above mean sea level (MSL); its volume was approximately 2.7 million acre feet; and its surface area was approximately 45,900 acres (186 square km). It is expected to take about 15-20 years for Mono Lake to reach a surface elevation of 6,392 feet (1,948 meters) MSL, a lake stabilization level ordered by the California Water Resources Control Board. Once that surface level is attained, Mono Lake should fluctuate around 6 feet (2 meters) in surface elevation and occasionally rise to as high as 6,395 feet (1,949 meters) MSL, and during extreme drought periods drop to as low as 6,382 feet (1,945 meters) MSL. Without restrictions on stream diversions, it has been estimated that Mono Lake would have eventually stabilized at approximately 6,355 feet (1,937 meters) MSL with fluctuations of 21 vertical feet (6 meters). During periods of extreme drought, the lake might have fallen to as low as 6,336 feet (1,931 meters) MSL. Mono Lake's average depth is approximately 58 feet (18 meters) and it has a maximum depth of 160 feet (49 meters). Mono Lake contains chlorides, carbonates, and sulfates – making it a chloride-carbonate-sulfate “triple water” lake.

It is highly alkaline, with a pH of 10, and almost three times as salty as the ocean. At a surface level of 6,392 feet MSL, Mono Lake will be slightly more than twice as salty as the ocean, or approximately 78 grams/liter, or 78,000 parts per million (ppm) of *Total Dissolved Solids (TDS)*. The primary lake life is composed of algae, brine shrimp, and alkali flies, and the lake basin is one of the most productive ecosystems in the world. Nesting birds consist of California Gulls (50,000, or 85 percent of California's breeding population and the second largest colony in the world after the Great Salt Lake in Utah) and Snowy Plovers (400, or 11 percent of the state's breeding population). Migratory birds include Eared Grebes (1.5-2 million, or 30 percent of the North American population), Wilson's Phalaropes (80,000, or 10 percent of the world population), Red-Necked Phalaropes (60,000, or 2-3 percent of the world population), and 79 other species of waterfowl. Another relatively unique feature of Mono Lake is its extensive tufa formations, which are essentially made from limestone. Within the lake underwater springs rich in calcium mix with lakewater which rich in carbonates, thereby forming calcium carbonate limestone. These calcium carbonate deposits form around springs, and over the course of decades to centuries, tufa towers grow to heights of over 30 feet. At Mono Lake so much tufa is visible today because the lake level has fallen dramatically after water diversions began to Los Angeles in 1941. Located on the eastern side of the Sierra Nevada north of Mount Whitney, Mono Lake occupies the northern portion of the Long Valley Caldera. Approximately 760,000 years before present (B.P.), the Long Valley eruption blasted more than 150 cubic miles of earth and ash skyward, burying much of the region under hundreds of feet of volcanic debris. It has been estimated that this volcanic eruption was 2,500 times greater than the Mt. St. Helens blast of 1980. The earth's surface collapsed more than one mile deep following the eruption, forming a 200 square mile depression called Long Valley Caldera. Today, the Long Valley Caldera is part of a large volcanic complex that stretches from Mammoth Mountain in the south to Mono Lake in the north. Within the Mono Lake basin, sagebrush, Jeffrey pines, volcanoes, tufa towers, gulls, grebes, brine shrimp, alkali flies, freshwater streams, and alkaline waters comprise an unlikely world at the transition zone between the Sierra Nevada to the west and the Great Basin Desert to the east. Embracing 14 different ecological zones, over 1,000 plant species, and roughly 400 recorded vertebrate species within its watershed, Mono Lake and its surrounding basin encompass one of California's richest natural ecological habitats. Based on continued water diversions out of the basin and a severe threat to Mono Lake's very existence, in 1994 the State of California Water Resources Control Board issued D1631 which ordered minimum flows and maintenance flows for all of the streams originally diverted out of the watershed in 1941. Under this historic invocation of the *Public Trust Doctrine* and a reassessment of permanency of the *Prior Appropriation Doctrine* in California, water exports out of the basin were virtually eliminated. Stream restoration plans approved in 1998 were based on a wet/normal/dry water year classification criteria. The yearly average water export from the Mono Lake Basin now depends on the level of Mono Lake on April 1 of each year. Below 6,377 feet MSL, no diversions from the basin are allowed. Between 6,377 feet and 6,380 feet MSL, an annual diversion of 4,500 acre-feet is allowed. Between 6,380 feet and 6,391 feet MSL, an annual diversion of 16,000 acre-feet is allowed. Once Mono Lake reaches 6,391 feet MSL, however, a new set of restrictions applies and no diversions are allowed if the lake drops below 6,388 feet MSL. The annual diversion of 10,000 acre-feet is allowed when the lake is between 6,388 and 6,391 feet MSL. All water (estimated to be on average 30,800 acre-feet per year) in excess of required stream flows (89,000 acre-feet) is allowed to be diverted when Mono Lake is above 6,391 feet MSL. If Mono Lake has not reached 6,392 feet MSL by the year 2014, the State Water Resources Control Board is required to re-examine the situation.

Monohydrate — A compound, such as calcium chloride monohydrate, $\text{CaCl}_2 \cdot \text{H}_2\text{O}$, that contains one molecule of water.

Monomictic — (1) Lakes or reservoirs which are relatively deep, do not freeze over during the winter, and undergo a single stratification and mixing cycle during the year (usually in the fall). (2) Lakes and reservoirs which are relatively deep, do not freeze over during the winter months, and undergo a single stratification and mixing cycle during the year. These lakes and reservoirs usually become destratified during the mixing cycle, usually in the fall of the year.

Monovalent — Having a valence of one, such as the cuprous (copper) ion, Cu^+ .

Monsoon — (1) A wind system that influences large climatic regions and reverses direction seasonally. (2) A wind from the southwest or south that brings heavy rainfall to southern Asia in the summer; the rain that accompanies this wind.

Montane — A forest *Ecosystem* or *Biome* in mountainous areas of the tropics. The montane forest has far fewer plant species than does the *Tropical Rain Forest*, which is found at lower elevations below the mountains.

Montane Alkali Lakes — Lakes with a water pH greater than 7.0 found in cool, upland habitats below the timber line.

Montane Freshwater Lakes — *Circumneutral* lakes found in cool, upland habitats below the timber line.

Monte Carlo Method — (Statistics) A method that produces a statistical estimate of a quantity by taking many random samples from an assumed probability distribution, such as a normal distribution. The method is typically used when experimentation is infeasible or when the actual input values are difficult or impossible to obtain.

Montmorillonite — Clay minerals which have a theoretical composition of essentially $\text{Al}_4\text{Si}_8\text{O}_{20}(\text{OH})_4 \cdot n\text{H}_2\text{O}$, where "n" is the number of attached water molecules.

Moor — (Ecology) (1) A tract of wasteland that is permanently wet and covered with grasses, low shrubs, and peat deposits. Such areas are found extensively in the British Isles. Also referred to as *Moorland*. (2) An extensive area of waste ground in high, poorly drained country, overlaid with peat, and usually more or less wet. In popular usage, the word is restricted to the European moors, in which heather is often the prevailing plant, but similar phytogeographical areas occur elsewhere. Sphagnum moss is always characteristic of high moors, and especially in North America various insectivorous (insect feeding) plants flourish in them.

Moorland — See *Moor*.

Morainal Lake — A *Glacial Lake* that occupies a depression produced by the irregular deposition of drift in a moraine of a continental glacier.

Moraine — (Geology) (1) Any mound, ridge, or other distinct accumulation of unsorted *Glacial Drift*, incorporated in or transported on a *Glacier*, or deposited by direct glacial action. (2) A mound, ridge, or other distinct accumulation of unsorted, unstratified

glacial drift, predominantly till, deposited chiefly by direct action of glacier ice. (3) An accumulation of boulders, stones, or other debris carried and deposited by a glacier. Moraines, which can be subdivided into many different types, are deposits of *Glacial Till*. *Lateral Moraines* are the ridges of till that mark the sides of the glacier's path. *Terminal Moraines* are the material left behind by the farthest advance of the glacier's toe. Each different period of glaciation leaves behind its own moraines. Also see *Recessional Moraine*.

Morphoedaphic Index (MEI) — The ratio of dissolved solids (measured as total dissolved solids, alkalinity, or conductivity) to mean lake depth; MEI has been used to predict the total fish production, phytoplankton standing crop, and total phosphorus concentration of lakes not subject to cultural *Eutrophication*.

Morphology — (1) The science of the structure of organisms. (2) The external structure form and arrangement of rocks in relation to the development of landforms. River morphology deals with the science of analyzing the structural make-up of rivers and streams. *Geomorphology* deals with the shape of the Earth's surface.

Most Probable Number (MPN) — (Water Quality) (1) A statistically determined number which represents the number of bacteria most likely present in a sample, based on test data. Widely used in the evaluation of waters from a bacterial standpoint. (2) An index of the number of coliform bacteria that, more probably than any other number, would give the results shown by the laboratory examination. It is not an actual enumeration. MPN is determined from the distribution of gas-positive cultures among multiple inoculated tubes.

Motile — Capable of self-propelled movement. A term that is sometimes used to distinguish between certain types of organisms found in water.

MOU — Memorandum of Understanding.

Moulin — (1) A nearly vertical shaft or cavity worn in a glacier by surface or rock debris falling through a crack in the ice. (2) A nearly vertical, cylindrical hole or shaft that has been worn in the ice of a *Glacier* by the swirling motion of meltwater as it pours down from the surface.

Mound System — A septic tank effluent disposal system in which a mound of soil is built up and effluent distributed in the mound about 3.3 feet (1 meter) above the normal soil surface.

[Groundwater] Mounding — Commonly, an outward and upward expansion of the free water table caused by shallow re-injection, percolation below and impoundment, or other surface recharge method (essentially, the reverse of the cone of depression effect created by a pumping well). Mounding can alter groundwater flow rates and direction; however, the effects are usually localized and may be temporary, depending upon the frequency and duration of the surface recharge events.

Mountain Glacier — See *Alpine Glacier*.

Mountain-Valley Fan — A major landform created by alluvial filling of a mountain valley or *Intramontane Basin* by coalescent valley-sideslope fans whose toeslopes meet from either side of the valley along an axial drainageway. It is an extension of the upper piedmont slope into mountain valleys. Most mountain-valley fans have been dissected.

Mouth of Stream — The point of discharge of a stream into another stream, a lake, or the sea.

Moutonnée (also Moutonné) — (Geology) Rounded by glacial action into a shape resembling a sheep's back. Used of a rock formation.

Movable Bed — A stream bed made up of materials readily transportable by the streamflow.

Moving Average Process — (Statistics) As a simple mathematical process, the moving average process is merely a moving, fixed-interval average of a *Time Series* of data used to smooth fluctuations and distortions in the data and provide a more meaningful representation of underlying trends and cycles. As applied to econometric model development, a moving average process is one whereby future data values are expressed as a linear combination of past errors.

MPN — Most Probable Number.

MRDL — Maximum Residual Disinfectant Level.

MRDLG — Maximum Residual Disinfectant Level Goal.

MTBE — See *Methyl Tertiary Butyl Ether (MTBE)*.

MTD — Maximum tolerated dose, the dose that an animal species can tolerate for a major portion of its lifetime without significant impairment or toxic effect other than carcinogenicity.

MTF — Multiple Tube Formation.

Muck — (1) A moist, sticky mixture, especially of mud and filth. (2) Highly decomposed organic material in which the original plant parts are not recognizable. Muck contains more mineral matter and is usually darker than *Peat*. (3) Earth, rocks, or clay excavated in mining. (4) (Geology) A dark, finely divided, well-decomposed organic material with a high percentage of mineral matter that accumulates on the surface in certain poorly drained areas, such as *Permafrost* regions.

Mud — (1) A slimy sticky mixture of solid material with a liquid and especially water; especially soft wet earth. (2) Also, wet soft earth composed predominantly of clay and silt—fine mineral sediments less than 0.074 mm (0.0029 inch) in diameter. (Geology) (3) A slimy, sticky, or slippery mixture of finely divided particles of clay or silt together with water and possibly other materials, whose consistency ranges from semifluid to soft and plastic. (4) Any very wet, soft soil or mass of earth.

Mud Ball (Mudball) — (Geology) (1) A rounded mass of mud or mudstone occurring in a sedimentary rock due to weathering and the breakup of clay deposits. (Water and Wastewater Treatment) (2) Material that is approximately round in shape and varies from pea-sized up to two or more inches in diameter. This material forms in filters and gradually increases in size when not removed by the backwashing process. (3) Accretions of siliceous incrustations on the exterior of sand grains in a rapid sand filter; typically removed by *Backwashing*. Such deposits interfere with effective filtration.

Mud Flat (or Mudflat) — (Geology) A relatively level, sandy, or silty strip along a shore or around an island. Also referred to as a *Flat*.

Mud Volcano — A conical hill of mud, from which material is ejected, generally cold, by and with various gases.

Muddle — To make turbid or muddy.

Mudflat — Low-lying muddy land that is covered at high tide and exposed at low tide; A level tract lying at little depth below the surface of water or alternately covered and left bare by the tide.

Mudflow (or Mud Flow) — (1) A rapidly moving stream of mixed soil or rock and water having the consistency and composition of mud. (2) Flow of a well-mixed mass of rock, earth, and water that behaves like a fluid and flows down slopes with a consistency similar to that of newly mixed concrete. (Geology) (3) A slow to rapid flowing mass of predominantly water-saturated, fine-grained earth material.

Mudslide — A condition where there is a river, flow or inundation of liquid mud down a hillside usually as a result of a dual condition of loss of brush cover, and the subsequent accumulation of water on the ground preceded by a period of unusually heavy or sustained rain. A mudslide may occur as a distinct phenomenon while a landslide is in progress.

Mudslide Prone Area — An area with land surfaces and slopes of unconsolidated material where the history, geology, and climate indicate a potential for mudflow.

Mulch — (1) Any substance spread or allowed to remain on the soil surface to conserve soil moisture and shield soil particles from the erosive forces of raindrops and runoff. (2) A substance placed over the soil surface to inhibit weed growth, conserve moisture, and in some cases, prevent heat loss. Examples include straw, wood chips, and leaves. (3) Any substance artificially applied to the soil surface, or incorporated into the surface layer of soil, designed to reduce evaporation of soil moisture, reduce soil temperature fluctuations, or accomplish other effects. Mulches often are organic substances. (4) A natural or artificial protective layer of suitable materials, usually of organic matter such as leaves, straw, or peat, placed around plants that aid in soil stabilization, soil moisture conservation, prevention of freezing, and control of weeds, thus providing micro-climatic conditions suitable for germination and growth of selected vegetation.

Mulching — The use of plant residues or other suitable materials on the soil surface, primarily to reduce evaporation of water and erosion of soil.

Multi-Cropping — The practice of producing two or more crops consecutively on the same parcel of land during a 12-month period. Also referred to as *Double Cropping*.

Multi-Stage Pump — A pump that has more than one impeller. A single-stage pump has one impeller.

Multiple-Current Hypothesis (Gulf Stream) — (Oceanography) A hypothesis proposing that the *Gulf Stream* is a system of many quasi-permanent currents and meanders, as distinguished from the traditional view that it is a shifting and highly variable single current.

Multiple-Plate Samplers — Artificial substrates of known surface area used for obtaining benthic invertebrate samples. They consist of a series of spaced, hardboard plates on an eyebolt.

Multiple-Purpose Reservoir — A reservoir planned and constructed to provide water for more than one purpose, e.g., irrigation, recreation, and flood control. Also referred to as *MultiPurpose Project*.

Multiple Regression (Model) — (Statistics) A *Regression Model* structure characterized by more than one *Explanatory*, or *Exogenous Variable*, of the form

$$Y_t = \alpha + \beta X_{1t} + \delta X_{2t} + \epsilon_t$$

where:

t represents the time periods of observation (where $t = 1, 2, \dots, n$);

Y_t represents the dependent (*Endogenous*) variable in time period t ;

α (*alpha*) represents the model equation's constant term (without a time reference);

β (*beta*, also a constant term without a time reference) represents the coefficient of the first independent variable;

X_{1t} represents the first independent variable in time period t ;

δ (*delta*, a constant term without a time reference) represents the coefficient of the second independent variable;

X_{2t} represents the second independent variable in time period t ; and

the error term, ϵ_t (*epsilon*), represents the value of the unexplained disturbance term.

Multiple Use — (1) When a water body has more than one beneficial use designation. (2) Harmonious and coordinated management of the various surface and subsurface resources, without impairment of the land, that will best meet the present and future needs of the people. Does not necessarily connote the combination of uses that will yield the highest economic return or greatest unit of output. (3) Use of land for more than one purpose; i.e., grazing of livestock, wildlife production, recreation, watershed, and timber production. Could also apply to use of bodies of water for recreational purposes, fishing, and water supply.

Multipurpose Project — A project designed to serve more than one purpose, and whose costs are normally allocated among the different functions it provides. For example, one that provides water for irrigation, recreation, fish and wildlife, habitat restoration and protection, and, at the same time, controls floods or generates electric power. Also see *Multiple Purpose Reservoir*.

Municipal and Industrial (M&I) Water Withdrawals (Use) — Water supplied for municipal and industrial uses provided through a municipal distribution system for rural domestic use, stock water, steam electric powerplants, and water used in industry and commerce.

Municipal Discharge — The discharge of effluent from waste water treatment plants which receive waste water from households, commercial establishment, and industries. Combined sewer/separate storm overflows are included in this category.

Municipal Sewage — Sewage (mostly liquid) originating from a community which may be composed of domestic sewage, industrial wastes, or both.

Municipal Use — The use of water by the state through its institutions, facilities, and properties or by a municipality, and, with

regard to municipal rights by the inhabitants thereof, for household, custodial care, and fire protection purposes, whether supplied by the government or by a privately owned public utility or other agency, primarily to promote the life, safety, health, comfort, and business pursuits of the state, municipality, and the inhabitants thereof. It does not include the irrigation of crops on a commercial scale, even within the limits of the state institution, facility property, or municipality. Nor does it include large recreational uses such as lakes.

Municipal Wastewater Facility — Refers to those facilities that receive or dispose of wastewater derived principally from residential dwellings, business or commercial buildings, institutions, and the like. May also include some wastewater derived from industrial facilities. Also referred to as *Domestic Wastewater Facility*.

Municipal Water — Municipal water may come from either groundwater or surface water sources. Once water has entered a municipal water system, from whatever source, it will be considered municipal water.

Municipal Watershed — The watershed from which the runoff is used for drinking purposes in a city.

Municipal Water System — A water system which has at least five service connections or which regularly serves 25 individuals for 60 days. See *Public Water System (PWS)*.

Muskeg — (Ecology) (1) A bog characterized by scattered and stunted evergreens. (2) Generally, any area of wetland vegetation. (3) A *Swamp* or *Bog* formed by an accumulation of sphagnum moss, leaves, and decayed matter resembling *Peat*. Prevalent in Canada and Alaska and part of the North American boreal forest *Biome*.

Mutagen — An agent that causes a permanent genetic change in a cell other than that which occurs during normal genetic recombination.

Mutagenic — Causing mutation, or the abrupt change in the genotype of an organism.

Mutagenicity — The capacity of a chemical or physical agent to cause an alteration of the genetic material within living cells.

Mutual Prescription — See *Doctrine of Mutual Prescription [California]*.

Mutchkin — (Scottish) A unit of liquid measure equal to 0.9 U.S. pint (0.42 liter).

Mycoremediation — (Water Quality) The use of mushroom beds or “mats” to filter contaminated water and soil. In the natural world, mushrooms, or fungi, feed off dead plants and animals, decomposing them in the process. Because the origin of many contaminants, including oil and gasoline, is in the natural world, their chemical structure is not so different than the normal material that mushrooms tend to thrive on. In mycoremediation, various fungal strains, either alone or in combinations, are “trained” to speed up the decomposition process and make it more efficient. The strains of mushrooms used are tailored to each specific contaminated site and are selected from a diverse biological “library” of available species. The technology also appears promising for cleaning up agricultural runoff. This is especially important to many agricultural states. For example, the State of California is presently struggling to stem the damage caused by the Central Valley’s polluted irrigation runoff.

N

“N” Factor — A coefficient value representing the pipe or channel roughness in *Manning’s Formula* for computing flows in gravity sewers. Also see *Friction Loss*.

N (or Normal) Solution — A normal solution contains one gram equivalent weight of reactant (compound) per liter of solution. The equivalent weight of an acid is that weight which contains one gram atom of ionizable hydrogen or its chemical equivalent. For example, the equivalent weight of sulfuric acid (H_2SO_4) is 49 (98 divided by 2 because there are two replaceable hydrogen ions). A one N solution of sulfuric acid would consist of 49 grams of H_2SO_4 dissolved in enough water to make one liter of solution.

90th Percentile — Term used in conjunction with water sampling standards as required under the *Safe Drinking Water Act (SDWA)* and amendments thereto. The 90th percentile value is calculated by first placing all sample results in order from the lowest concentration to the highest concentration (i.e., concentration of specific contaminants). Next, assign each sample result a number, starting with the number 1 for the lowest (concentration) result up to the highest concentration being given the number equal to the total number of samples collected from a particular water supply system. Then multiply the total number of samples collected by 0.9. The sample result with the number corresponding to this calculated value is the 90th percentile.

Nadir — Refers to a low or the lowest point, as the lowest point of a lake or other body of water attained of a certain period of time (period of record).

NAICS — See *North American Industry Classification System*.

Nanograms per Liter (ng/L) — A unit expressing the concentration of chemical constituents in solution as mass (nanograms) of solute per unit volume (liter) of water. One million nanograms per liter is equivalent to 1 milligram per liter (mg/L).

Nanoplankton — Very minute plankton not readily retained in ordinary plankton nets.

Nansen Bottle — (Oceanography) An ocean-water sampling bottle with spring-loaded valves at both ends that are closed at an appropriate depth by a messenger device sent down the wire connecting the bottle to the surface; made of a metal alloy that reacts little with seawater.

Nappe, also Nap — (1) A sheet or curtain of water flowing over a dam or weir or similar structure. (2) (Geology) A large sheetlike body of rock that has been moved far from its original position.

Narghile — A water pipe that originated in the Near East.

Narrow — (1) A body of water with little width that connects two larger bodies of water. When the water freely flows over any structure, it has a well defined upper and lower water surface. (2) A part of a river or an ocean current that is not wide. Often used in the plural, i.e., narrows.

Natant — Floating or swimming in water.

Nathansohn’s Theory — (Oceanography) The theory that purports that nutrient salts move cyclically in the ocean, being absorbed by plants in the euphotic surface layer, accumulating on the sea floor as dead plants and animal bodies sink to the bottom, and then return to the surface layer through diffusion and the vertical circulation of the water. However, more recent research tends to indicate that this theory may apply to shallow-water deposition, but that most organic materials are recycled continuously in the upper layers and that only small amounts of organic materials ever reach the ocean floor below the upper bathyal depths (i.e., 1,000-2,000 meters; i.e., 3,300-6,600 feet).

National Atmospheric Deposition Program (NADP) [EPA] — A national *Atmospheric Deposition* monitoring network composed of deposition monitoring stations throughout the country equipped and designed to measure precipitation and atmospheric deposition rates. Samples are sent to a central laboratory for analysis creating a national picture of atmospheric deposition.

National Audubon Society — An American environmental interest group founded in 1905 that emphasizes natural resource and wildlife conservation and protection. Named in honor of John James Audubon (1785–1851), who was one of the first American conservationists and who gained recognition for his paintings of birds.

National Centers for Coastal Ocean Science (NCCOS) [NOS/NOAA] — The National Centers for Coastal Ocean Science, part of the *National Ocean Service (NOS)*, *National Oceanic and Atmospheric Administration (NOAA)*, works to understand the ocean and coastal environment, and the influences of human activities on that environment, by conducting research, monitoring, and assessments of these sensitive and critical areas. The vision of the NCCOS is to provide the foundation for coastal ocean, estuarine, and Great Lakes science and offer the best available research, products, and services to improve stewardship of the Nation’s coastal and Great Lake environments. The mission of the NCCOS is to provide a sound scientific basis for NOAA’s coastal programs, products, and services by developing and maintaining a broad cadre of scientific experts and science capabilities through both intramural and extramural research, monitoring, and assessment programs. NCCOS activities include:

- [1] Understanding and predicting impacts of pollution and coastal development on sensitive habitats and resources;
- [2] Helping to protect coastal property and residents from storms and other natural hazards;
- [3] Understanding the causes and consequences of harmful algal blooms, such as red tides and toxic *Pfiesteria piscicida*; and
- [4] Understanding how climate change may affect our lives; and determining the complex factors that effect fish

populations.

Other nations, U.S. federal agencies, state and county governments, academic institutions, and other scientists, researchers, and activists involved in coastal and ocean-related activities have come to depend on NCCOS to provide leadership, timely scientific data, technical assistance, and coordination in order to clearly identify and help solve the problems that threaten our oceans and fragile coastal areas. NCCOS has taken the lead responsibility for several national and regional programs, to include:

- National Algal Bloom Program;
- Gulf of Mexico Hypoxia Assessment;
- South Florida Restoration activities;
- Report Card on the Nation's Ecosystems;
- Coastal and Marine Climate Assessment; and
- White House Council on the Environment and Natural Resources Ecosystem Initiative.

National Drought Policy Act of 1998 (Public Law 105-99) — An act of Congress calling for the creation of an advisory commission – the National Drought Policy Commission – to provide advice and recommendations on the creation of an integrated, coordinated federal policy designed to prepare for and respond to serious drought emergencies. In the report subsequently released by the commission in May 2000, it was stressed that planning response actions need to be considered before droughts occur in order to reduce the need for emergency relief actions. One of the reports most relevant recommendations was that *U.S. Geological Survey (USGS)* stream gaging networks be expanded and modernized.

National Economic Development — One of the two main objectives of planning for water and related land resources by governmental agencies whose activities involve planning and development of water resources. Such activities are reflected in the increase in the nation's productive output, an output which is partly reflected in a national product and income accounting framework to measure the continuing flow of goods and services into direct consumption or investment.

National Energy Policy Act (EPAct) — See *(National) Energy Policy Act (EPAct)*.

National Environmental Policy Act (NEPA) — Legislation passed in 1969, that identified a national policy to “use all practicable means” to minimize environmental impact of federal actions. The Act specifically requires decisions regarding all federally controlled or subsidized projects, such as highways, dams, airports, etc., to outline possible adverse impacts in an *Environmental Impact Statement (EIS)*. NEPA also established the Council on Environmental Quality in the executive branch, which develops and recommends new environmental policies to the President of the United States.

National Environmental Training Association (NETA) — A professional organization devoted to serving the environmental trainer and promoting better operation of waterworks and pollution control facilities.

National Estuarine Research Reserve System (NERRS) [OCRM/NOS/NOAA] — A program administered by the *Office of Ocean and Coastal Resource Management (OCRM)*, the National Estuarine Research Reserve System protects and studies estuarine areas through a network of 25 reserves located in the United States and Puerto Rico. Two other reserves have been proposed for addition to the NERRS. The NERRS helps to fulfill the *National Oceanic and Atmospheric Administration's (NOAA)* stewardship mission to sustain healthy coasts by improving the nation's understanding and stewardship of estuaries. Established by the *Coastal Zone Management Act (CZMA)* of 1972, as amended, each reserve is a “living laboratory” in which scientists conduct research and educators communicate research results. Reserve staff members work with local communities and regional groups to address natural resource management issues, such as nonpoint source pollution, habitat restoration and invasive species. Through integrated research and education, the reserves help communities develop strategies to deal successfully with these coastal resource issues. The NERRS protects more than one million acres of estuarine habitat, conducts essential research, and provides a variety of educational opportunities. Individual National Estuarine Research Reserves focus on local and regional research and educational needs, but as a national network there are also many system-wide programs. These programs provide the reserves with common research standards and educational goals. NERRS programs include:

- **System-Wide Monitoring Program (SWMP)** – Measures changes in estuarine water quality, habitat, and land use to ensure that the nation's coastal areas are healthy. It provides information on national environmental trends, while allowing flexibility for coastal managers to gain a better understanding of regional or local issues;
- **Graduate Research Fellowship (GRF) Program** – Supports the reserves' scientific activities while providing graduate students with hands-on field experience. The GRF Program offers qualified master's and doctoral students the opportunity to address scientific questions of local, regional and national significance. The result is high-quality research focused on improving coastal management issues; and
- **Coastal Decision-Maker Workshops** -- Through a variety of workshops, the reserves provide up-to-date scientific information for elected officials, land-use planners, regulators, natural resource managers and private citizens who wish to make informed decisions about the nation's coasts and estuaries.

The following is a list of the National Estuarine Research Reserves in alphabetical order and the states in which they are located:

- [1] **Ace Basin Reserve (South Carolina)** – Headquartered south of Charleston, South Carolina, the reserve encompasses parts of Colleton, Charleston, Beaufort and Hampton counties; Acreage - 134,710; Designation - 1992.
- [2] **Apalachicola Reserve (Florida)** – The reserve is located in Franklin County, on the Florida panhandle, approximately 90 miles southeast of Tallahassee and 80 miles east of Panama City, Florida; Acreage - 246,000; Designation - 1979.
- [3] **Chesapeake Bay Reserve - MD (Maryland)** – The Jug Bay component of the reserve is located 20 miles from Washington, D.C.; the Otter Point Creek component is 19 miles northeast of Baltimore; the Monie Bay component is located 20 miles from Salisbury, Maryland; Total Acreage - 4,820; Monie Bay - 3,426; Jug Bay - 722; Otter Point Creek - 672; Designation - 1985, 1990.

- [4] Chesapeake Bay Reserve - VA (Virginia) – The reserve is located within the York River Basin, approximately one hour north of Norfolk, Virginia; Acreage - 4,435; Designation - 1991.
- [5] Delaware Reserve (Delaware) – The Delaware National Estuarine Research Reserve (DNERR) offices are located at the St. Jones Component, along the St. Jones River, six miles southeast of Dover, Delaware; the Blackbird Creek Component is located in southern New Castle County along the Blackbird Creek; Acreage - 8,600 (including open bay water); Designation - 1993.
- [6] Elkhorn Slough Reserve (California) – The reserve is located 3.5 miles east of Moss Landing; Acreage - 1,400; Designation - 1979.
- [7] Guana Tolomato Matanzas Reserve (Florida) – The reserve is divided by the city of St. Augustine, Florida. It stretches approximately 30 miles north and 30 miles south of city in St. Johns and Flagler counties; Acreage - 55,000; Designation - 1999.
- [8] Grand Bay Reserve (Mississippi) – The reserve is located in Jackson County in southeast Mississippi between Pascagoula and the Alabama state line; Acreage - 18,400; Designation - 1999.
- [9] Great Bay Reserve (New Hampshire) – The reserve is located 10 miles inland from the coast of New Hampshire and the Maine border; Acreage - 5,280; Designation - 1989.
- [10] Hudson River Reserve (New York) – The Hudson River Reserve is a network of four coastal wetlands located along 100 miles of the Hudson Estuary in New York state. The reserve components are: Piermont Marsh and Iona Island, in Rockland County; Tivoli Bays, in Dutchess County; and Stockport Flats, in Columbia County; Acreage - 4,838; Designation - 1982.
- [11] Jacques Cousteau Reserve (New Jersey) – The reserve is located eight miles southeast of exit 58, on Garden State Parkway, in Tuckerton, New Jersey; Acreage - 114,665; Designation - 1998.
- [12] Jobos Bay Reserve (Puerto Rico) – The reserve is located on the southern coast of Puerto Rico, between the municipalities of Guayama and Salinas; Acreage - 2,883; Designation - 1981.
- [13] Kachemak Bay Reserve (Alaska) – The reserve is approximately 150 miles south of Anchorage, on the western coast of the Kenai Peninsula; Acreage - 365,000; Designation - 1999.
- [14] Narragansett Bay Reserve (Rhode Island) – The reserve is in the geographic center of Narragansett Bay, 12 miles north of Newport and 12 miles south of Providence, Rhode Island; Acreage - 3,845; Designation - 1980.
- [15] North Carolina Reserve (North Carolina) – The reserve is comprised of four sites located near Corolla (Currituck Banks), Beaufort (Rachel Carson), and Wilmington (Masonboro Island and Zeke's Island); Acreage - 10,000; Designations - Currituck Banks, Rachel Carson, and Zeke's Island - 1985; Masonboro Island - 1991.
- [16] North Inlet/Winyah Bay Reserve (South Carolina) – The reserve is located in Georgetown County, South Carolina, 30 miles south of Myrtle Beach and 50 miles north of Charleston; Acreage - 12,327; Designation - 1992.
- [17] Old Woman Creek Reserve (Ohio) – The Old Woman Creek Reserve is located on the south-central shore of Lake Erie in Erie County, Ohio, three miles east of Huron; Acreage - 571; Designation - 1980.
- [18] Padilla Bay Reserve (Washington) – Padilla Bay Reserve is located on North Puget Sound near Anacortes, Washington; Acreage - 11,000; Designation - 1980.
- [19] Rookery Bay Reserve (Florida) – The reserve is five miles south of Naples, Florida; Acreage - 12,500; Designation - 1978.
- [20] Sapelo Island Reserve (Georgia) – The reserve is seven and half miles northeast of Darien, Georgia; Acreage - 17,950; Designation - 1976.
- [21] South Slough Reserve (Oregon) – The reserve is located five miles south of the city of Charleston, Oregon, on the South Slough of the Coos Bay estuary; Acreage - 4,700; Designation - 1974.
- [22] Tijuana River Reserve (California) – The reserve is located near Imperial Beach, in San Diego County, on the Mexican border; Acreage - 2,500; Designation - 1982.
- [23] Wauquoit Bay Reserve (Massachusetts) – The reserve is located on the south shore of Cape Cod, in the towns of Falmouth and Mashpee; Acreage - 2,500; Designation - 1988.
- [24] Weeks Bay Reserve (Alabama) – The reserve is located between Mobile, Alabama and Pensacola, Florida; Acreage - 3,000; Designation - 1986.
- [25] Wells Reserve (Maine) – The reserve is located on Laudholm Farm Road off U.S. Route 1 in Wells, Maine, just south of State Route 9; Acreage - 1,600; Designation - 1986.

Proposed National Estuarine Research Reserves include:

- [1] San Francisco Bay Reserve (California)
- [2] St. Lawrence River Reserve (New York)

National Estuary Program (NEP) [EPA] — The National Estuary Program was established in 1987 by amendments to the *Clean Water Act (CWA)* to identify, restore, and protect nationally significant Estuaries of the United States. It is the mission of the NEP to restore and protect America's nationally significant estuaries. Through its approach of inclusive, community-based planning and action on the watershed level, the NEP is an important initiative in conserving our estuarine resources, and an effective model for the protection and management of other coastal areas. Unlike traditional regulatory approaches to environmental protection, the NEP targets a broad range of issues and engages local communities in the process. The program focuses not just on improving water quality in an estuary, but on maintaining the integrity of the whole system – its chemical, physical, and biological properties, as well as its economic, recreational, and aesthetic values. The NEP is designed to encourage local communities to take responsibility for managing their own estuaries. Active participation of communities and local groups

through effective development and implementation of Comprehensive Conservation Management Plans is a hallmark of the NEP. Each plan identifies specific actions to control pollutants such as point and nonpoint sources of toxics and nutrients, restore or create wetlands and other habitats, control discharges from septic tanks, and undertake other activities. Each NEP is made up of representatives from federal, state, and local government agencies responsible for managing the estuary's resources, as well as members of the community – citizens, business leaders, educators, and researchers. These stakeholders work together to identify problems in the estuary, develop specific actions to address those problems, and create and implement a formal management plan to restore and protect the estuary. Twenty-eight estuary programs are currently working to improve and protect the health of some of the nation's most important coastal waters. The *U.S. Environmental Protection Agency (EPA)* administers the National Estuary Program, but program decisions and activities are carried out by committees of local government officials, private citizens, and representatives from other federal agencies, academic institutions, industry, and estuary user-groups. Estuaries are selected for inclusion in the NEP through a nomination process. Nominations must be submitted to the EPA during designated nomination periods by the governors of the states where the estuary is located. [Note: The *Chesapeake Bay Estuary* is omitted from this national program as it was covered previously under a separate regional program.] The following is an alphabetical listing of estuaries currently enrolled in the NEP:

- [1] Albemarle-Pamlico Sounds – North Carolina
- [2] Barataria-Terrebonne Estuarine Complex – Louisiana
- [3] Barnegat Bay – New Jersey
- [4] Buzzards Bay – Massachusetts
- [5] Casco Bay – Maine
- [6] Charlotte Harbor – Florida
- [7] Coastal Bend Bays and Estuaries – Texas
- [8] (Lower) Columbia River Estuary – Oregon and Washington
- [9] Delaware Estuary – Delaware, New Jersey, and Pennsylvania
- [10] Delaware Inland Bays – Delaware
- [11] Galveston Bay – Texas
- [12] Indian River Lagoon – Florida
- [13] Long Island Sound – New York and Connecticut
- [14] Maryland Coastal Bays – Maryland
- [15] Massachusetts Bays – Massachusetts
- [16] Mobile Bay – Alabama
- [17] Morro Bay – California
- [18] Narragansett Bay – Rhode Island
- [19] New Hampshire Estuaries – New Hampshire
- [20] New York–New Jersey Harbor (Harbor Estuary Program) – New York and New Jersey
- [21] Peconic Bay – New York
- [22] Puget Sound – Washington
- [23] San Francisco Estuary – California
- [24] San Juan Bay – Puerto Rico
- [25] Santa Monica Bay – California
- [26] Sarasota Bay – Florida
- [27] Tampa Bay – Florida
- [28] Tillamook Bay – Oregon

National Fish and Wildlife Foundation (NFWF) — The National Fish and Wildlife Foundation supports the conservation of native fish, wildlife, plants, and their habitats by attracting diverse investments to conservation and encouraging locally supported stewardship on private and public lands. Congress created the Foundation in 1984 to benefit the conservation of fish, wildlife, and plants, and the habitat on which they depend. The Foundation does not support lobbying, political advocacy, or litigation. The Foundation awards funds to projects benefitting conservation education, habitat protection and restoration, and natural resource management. Federal and private funds contributed to the Foundation are awarded as challenge grants to on-the-ground conservation projects. The Foundation fosters partnerships among federal, tribal, state, and local governments, corporations, private foundations, individuals, and non-profit organizations. Funds have been awarded to more than 1,100 grantees, including government agencies, educational institutions, and domestic and international conservation organizations. The NFWF awards challenge grants, requiring that the funds awarded are matched with non-federal contributions, maximizing the total investment delivered to conservation projects. For every dollar that Congress provides to the Foundation, an average of \$3 in on-the-ground conservation takes place. The Foundation has made more than 4,400 grants, committing over \$165 million in federal funds, matched with non-federal dollars, delivering more than \$500 million for conservation. Congressionally-appropriated funds entrusted to the Foundation are multiplied and delivered to conservation projects; none are used for operating expenses. The Foundation depends upon private contributions for its operating funds, and is recognized for its ability to stretch contributions. It is estimated that more than 97 percent of combined NFWF revenues goes directly to conservation projects. The following lists the NFWF headquarters and regional office locations:

- [1] National and International NFWF Offices – Washington, DC;
- [2] Intermountain West Regional Office – Rocky Mountain Arsenal National Wildlife Refuge, Commerce City, Colorado;

- [3] Midwest/Mississippi River Valley Regional Office – Fortt Snelling, Minnesota;
- [4] Northeast Regional Office – Boston, Massachusetts;
- [5] Pacific Northwest Regional Office – Portland, Oregon;
- [6] Southeast Regional Office – Atlanta, Georgia;
- [7] Southwest Regional Office – San Francisco, California; and
- [8] Texas-Oklahoma Regional Office – Dallas, Texas.

National Flood Insurance Program (NFIP) — (1) The program under which communities may be eligible for federal flood insurance on the condition that they enact satisfactory *Floodplain Management Regulations*. (2) A federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. Participation in the NFIP is based on an agreement between local communities and the federal government that if a community will implement and enforce measures to reduce future flood risks to new construction in Special Flood Hazard Areas (SFHA), then the federal government will make flood insurance available to protect against flood losses that do occur. The NFIP was established by Congress through the passage of the National Flood Insurance Act of 1968. Features of the program were modified and extended with the 1973 passage of the Flood Disaster Protection Act, and other legislative measures. The NFIP is administered by the Federal Insurance Administration (FIA), and the Mitigation Directorate (MT), which are components of the *Federal Emergency Management Agency (FEMA)*, an independent federal agency.

National Forest — A federal reservation, generally forest, range, or wildland, which is administered by the Forest Service, U.S. Department of Agriculture, under a program of multiple use and sustained yield for timber production, range, wildlife, watershed, and outdoor recreation purposes.

National Geodetic Survey (NGS) [NOAA] — The National Geodetic Survey, part of the *National Oceanic and Atmospheric Administration (NOAA)*, defines and manages the National Spatial Reference System (NSRS), which constitutes the framework for latitude, longitude, height, scale, gravity, orientation, and shoreline throughout the United States. Since 1807, the NGS and its predecessor agencies have led the world in precise positioning and developed emerging technologies for the public. The NSRS provides the foundation for transportation, communication, and defense systems, boundary and property surveys, land records systems, mapping and charting, and a multitude of scientific and engineering applications. NGS also conducts research to improve the collection, distribution, and use of spatial data. NGS conducts aerial photography surveys near airports in the United States and its possessions to position obstructions and aids to air travel. It maps the coastal regions of the United States and its possessions to position the shoreline and other features needed to construct navigational charts.

National Geodetic Vertical Datum (NGVD) — (1) As corrected in 1929, a vertical control measure used as a reference for establishing varying elevations. (2) Elevation datum plane previously used by the *Federal Emergency Management Agency (FEMA)* for the determination of flood elevations. FEMA currently uses the *North American Vertical Datum Plane*.

National Geodetic Vertical Datum of 1929 (NGVD of 1929) — A geodetic datum derived from a general adjustment of the first order level nets of the United States and Canada. It was formerly called “Sea Level Datum of 1929” or “mean sea level” in the USGS series of reports. Although the datum was derived from the average sea level over a period of many years at 26 tide stations along the Atlantic, Gulf of Mexico, and Pacific Coasts, it does not necessarily represent local mean sea level at any particular place.

National Ground Water Association (NGWA) — The National Ground Water Association is the industry leader in continuing professional education, offering short courses and workshops throughout the nation. The NGWA offers on-line bookstore and other educational materials and also conducts annual trade shows. NGWA membership totals approximately 16,500. Membership in the NGWA is divided into four membership divisions: (1) Contractors; (2) Scientists and engineers; (3) Manufacturers; and (4) Wholesale distributors. Special interest groups of the NGWA include the horizontal wells interest group; the underground thermal energy storage interest group; the groundwater modeling interest group; and the regulators interest group. Affiliated organizations are located in 46 states and one foreign country. International cooperative agreements exist with the Australian Drilling Industry Association, Associação Brasileira de Aguas Subterraneas (Brazilian Ground Water Association), the Canadian Ground Water Association, and the Industrial Society of Well Drilling in Taiwan Area. The NGWA operates the National Ground Water Information Center, the largest non-governmental clearinghouse on groundwater science and well technology in the world. The NGWA library holds more than 40,000 volumes. The NGWA’s Ground Water On-Line®, a nearly 82,000 citation bibliographic data base of groundwater literature, is available at no cost to NGWA members through the Association’s World Wide Web site (Internet Sites: www.ngwa.org and www.wellowner.org). A database of standards, guidelines, criteria, practices and procedures is also available at the Web site. NGWA also provides an On-Line Ground Water Bookstore, consisting of a source for publications, videos, slides and other materials related to groundwater science and well technology.

National Institutes for Water Resources (NIWR) [USDI] — A network of research institutes in every state which conducts basic and applied research to solve water problems unique to each institute’s particular area. The bulk of the funding for these programs comes from non-federal sources. The *Water Resources Research Act* authorized by Public Law 101-397 provides for a *Water Resources Research Institute (WRRI)* in each of the 50 states, the trust territories, and the District of Columbia (for a total of 54 such institutes). The National Water Resources Research Institute Program objectives stipulated by the Water Resources Research Act provide a unified focus for the federal and non-federal components of the Institute program. Oversight of the program is conducted by the Secretary of the U.S. *Department of Interior (USDI)*. Under the Act, these institutes are to:

- [1] Plan, conduct, or otherwise arrange for competent research that fosters (a) the entry of new research scientists into the water resources fields, (b) the training and education of future water scientists, engineers, and technicians, (c) the preliminary exploration of new ideas that address water problems or expand understanding of water and

- water-related phenomena, and (d) the dissemination of research results to water managers and the public; and
- [2] Cooperate closely with other colleges and universities in the State that have demonstrated capabilities for research, information dissemination, and graduate training in order to develop a statewide program designed to resolve State and regional water and related land problems. Each institute shall also cooperate closely with other institutes and other organizations in the region to increase the effectiveness of the institutes and for the purpose of promoting regional coordination;

The Water Resources Research Institute for each state is located at a college or university designated by the Governor or State Legislature. Funding for the WRII program requires a 2:1 non-federal match and must meet the following criteria as specified in Section 104 (d): "Prior to and as a condition of the receipt each fiscal year of funds appropriated under subsection (f) of this section, each institute shall submit to the Secretary of the Interior for his approval a water research program that includes assurances, satisfactory to the Secretary, that such program was developed in close consultation and collaboration with the director of that state department of water resources or similar agency, other leading water resources official within the state, and interested members of the public." The state based program promotes research, training, information dissemination, and other activities meeting the needs of the states and nation, and encourages regional cooperation among institutes in research into areas of water management, development, and conservation that have a regional or national character. The federal authorization requirements provide positive influence on the overall program of the NIWR by:

- Providing the base for each Institute to establish cooperative programs with local governments, state agencies, and industry;
- Supporting and promoting multi-disciplinary problem solving research;
- Promoting general water education programs targeted to both youth and adults;
- Promoting specialized training or advanced technical sessions for water related professionals;
- Linking together faculty and facilities at all institutions of higher education in the United States to improve efficiency and reduce duplication; and
- Providing the motivation to foster coordination among the states through the national network.

Consistent with authorizing legislation, a common thread of the National Water Resources Research Institute Program links all the WRIIs. These fundamental program objectives include:

- [1] **Research** – The WRIIs manage research projects addressing a wide range of problems and issues. Representatives of the water interests in each state participate in the research program development. This results in research programs that individually target local, state and regional needs, and that collectively address issues of national priority. Recent high priority research topics focus on issues involving water quality (both ground and surface water) and toxic substances;
- [2] **Information Transfer** – The WRIIs maintain a vigorous program to transfer technical information from the producer to the user. The primary means of communicating research results is through written reports, theses, journal articles, books, and major conferences. Nearly one-fourth of the publications are in refereed journals. Most publications are also available on the Internet and the National Technical Information Service. In addition to disseminating information to the scientific community, the Institutes also provide outreach to other research users through newsletters and conferences; and
- [3] **Education and Training** – The WRII program helps to insure a continuing flow of water scientists and managers to the profession. The training program includes professional and academic training on campus and continuing education off campus. Students receive professional training by participating in Institute-sponsored research and information transfer projects. Seminars and specialized course work for graduate and undergraduate students are also sponsored.

National Marine, Protection, Research and Sanctuaries Act [NOAA] — This 1972 act established a system of marine protected areas called *National Marine Sanctuaries*. Under a *National Marine Sanctuary Program*, this new system of marine preserves would be administered by the *National Oceanic and Atmospheric Administration (NOAA)*, which itself was only established two years earlier in 1970. This Act also included Title III, later called the *National Marine Sanctuaries Act*, which charged the Secretary of the Department of Commerce to identify, designate, and manage marine sites based on conservation, ecological, recreational, historical, aesthetic, scientific or educational value within significant national ocean and Great Lake waters. In 1975 the nation's first marine sanctuary was created to preserve the wreckage of the USS Monitor, a Civil War ironclad vessel resting in 240 feet of water and 16 miles off the coast of North Carolina. Today, twelve marine sanctuaries and one Great Lakes sanctuary have been designated.

National Marine Sanctuary Program [NOAA] — Like the National Park System administered by the U.S. National Park Service (NPS), marine areas identified for their biodiversity, ecological integrity, and cultural legacy could now receive protection through the *National Marine Sanctuary Program*. The mission the program is to serve as the trustee for the nation's system of marine protected areas, to conserve, protect, and enhance their unique biodiversity, ecological, and cultural features. The program, administered by *National Oceanic and Atmospheric Administration (NOAA)*, was created in Title III of the *National Marine Protection, Research and Sanctuaries Act* of 1972. It brings a ecosystem approach to marine environmental protection and asks us to adopt a new ethic of marine stewardship, but perhaps most of all, it challenges us all to work together to find creative solutions to the problems facing our oceans and coasts. See *National Marine Sanctuaries*.

National Marine Sanctuaries [NOAA] — National Marine Sanctuaries, approved for creation by Title III of the *National Marine Protection, Research and Sanctuaries Act* of 1972, and administered by the *National Oceanic and Atmospheric Administration (NOAA)* under the *National Marine Sanctuary Program*, represent marine and aquatic areas that have been officially designated

for their biodiversity, ecological integrity, and cultural legacy. National Marine Sanctuaries now receive similar protections that the U.S. National Park Services affords the nation's land-based *National Parks*. The United States' national marine sanctuaries fill the gaps in existing marine resource protections and complement water quality and environmental regulations already in place. In more recent years, Sanctuary Advisory Councils have enlarged community involvement in sanctuary management by using the talents of individuals from residents, local governments, tourism, education, business, and the environmental community. The following marine sanctuaries have been designated (listed alphabetically):

- [1] **Channel Islands National Marine Sanctuary** – Designated in September 1980, this marine sanctuary is located 25 miles (40 km) off the coast of Santa Barbara, California. The sanctuary encompasses the waters surrounding Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara islands, extending from mean high tide to seven miles (11 km) offshore.
- [2] **Cordell Bank National Marine Sanctuary** – Designated in 1989, this marine sanctuary encompasses 526 square miles (1,360 square km) of Pacific Ocean, including and surrounding the Cordell Bank. The sanctuary is located about 52 miles (84 km) northwest of the Golden Gate Bridge at the edge of the continental shelf, with an average water depth of about 200 feet (60 meters) deep.
- [3] **Fagatele Bay National Marine Sanctuary** – Designated on April 29, 1986, Fagatele Bay is the smallest and most remote of all the national marine sanctuaries encompassing only 163 acres (0.25 square mile) and located on Tutuila, the largest island of American Samoa. American Samoa lies approximately 1,000 miles (1,600 km) south of the equator and over 2,200 miles (3,540 km) from Honolulu, and is composed of five volcanic islands: Tutuila, Anunu, Ofu, Olosega, and Tau and two small coral atolls: Rose and Swain islands.
- [4] **The Florida Keys National Marine Sanctuary** – Designated in 1990, the Florida Keys is an archipelago of 1,700 islands that is known world wide for its extensive offshore coral reefs. The sanctuary extends 220 miles (350 km) in a northeast to southwest arc between the southern tip of Key Biscayne, south of Miami, to beyond, but not including, the Dry Tortugas Islands.
- [5] **Flower Garden Banks National Marine Sanctuary** – First designated in 1992 and later expanded in 1996, Flower Garden Banks is located about 110 miles (180 km) off the coasts of Texas and Louisiana, covers 54 square miles (140 square km) and contains 350 acres of reef crest. The area harbors the northernmost coral reefs in the U.S. and serves as a regional reservoir of shallow water Caribbean reef fishes and invertebrates.
- [6] **Gray's Reef National Marine Sanctuary** – Gray's Reef comprises one of the largest nearshore sandstone reefs in the southeastern United States. The sanctuary was designed in 1981 and is located 20 miles (32 km) off Sapelo Island, Georgia, and contains 17 square miles (44 square km) of open ocean. Sandstone outcroppings and ledges up to ten feet in height separate the sandy, flat-bottomed troughs in a reef that combines temperate and tropical qualities.
- [7] **Farallones National Marine Sanctuary** – Designated in 1981, this sanctuary consists of 1,255 square miles (3,250 square km) and is located just north and west of San Francisco Bay some 30 miles (48 km) west of the Golden Gate Bridge. The sanctuary consists of a large expanse of Pacific Ocean along with nearshore tidal flats, rocky intertidal areas, wetlands, subtidal reefs, and coastal beaches.
- [8] **Hawaiian Islands Humpback Whale National Marine Sanctuary** – Designated in 1992 and formally approved by the State of Hawaii in 1997, this sanctuary constitutes one of the world's most important North Pacific humpback whale (*Megaptera novaeangliae*) habitats and the only place in U.S. waters where humpbacks reproduce. The sanctuary encompasses the waters around the main Hawaiian Islands of Kauai, Oahu, Hawaii, Maui, Molokai, Lanai and Kaho'olawe.
- [9] **Monitor National Marine Sanctuary** – Designated in 1975, this sanctuary represents the first national marine sanctuary (and the only site preserved solely for its "cultural legacy") and is the wreck site of the ironclad USS Monitor, which was lost in a storm during the Civil War. The sanctuary is approximately 16 miles (26 km) SSE of Cape Hatteras at a depth of about 240 feet (73 meters). The wreck and the waters above it are protected by an area one mile (1.6 km) in diameter.
- [10] **Monterey Bay National Marine Sanctuary** – This sanctuary was designated in 1992 and encompasses the waters of Monterey Bay and the adjacent Pacific Ocean off the central California coast. This vast area stretches 400 miles (645 km) north to south, extends an average of 35 miles (56 km) offshore, and covers over 5,300 square miles (13,740 square km).
- [11] **Olympic Coast National Marine Sanctuary** – Designated in 1994, this sanctuary covers over 3,300 square miles (8,600 square km) of ocean waters off Washington State's rugged and rocky Olympic Peninsula coastline. The sanctuary's waters extend an average of 35 miles (56 km) offshore and span 135 miles (217 km) north to south, stretching from United States/Canada international boundary south to the Copalis River.
- [12] **Stellwagen Bank National Marine Sanctuary** – Designated in 1992, this sanctuary consists of a sand and gravel plateau at the mouth of Massachusetts Bay. First discovered in 1854, Stellwagen Bank is described in the diary of Captain Henry Stellwagen, a hydrographer for the U.S. Navy, as "an important discovery in the location of a fifteen fathom bank lying in a line between Cape Cod and Cape Ann." In 1996, the name was changed to the Gerry E. Studds Stellwagen Bank Marine Sanctuary.
- [13] **Thunder Bay National Marine Sanctuary and Preserve** – Designated in 2002, this region, the only freshwater "marine" sanctuary, is located on Lake Huron off Alpena, Michigan, and contains approximately 160 shipwrecks that span more than a century of Great Lakes maritime history. The lake's murky fog banks and sudden gales, coupled with rocky shoals, helped Thunder Bay earn the unfortunate name of "Shipwreck Alley."

National Monument — An area owned by the federal government and administered by the National Park Service, U.S. Department of the Interior, for the purpose of preserving and making available to the public a resource of archaeological, scientific, or aesthetic interest.

National Municipal Plan — A policy created in 1984 by the U.S. Environmental Protection Agency (EPA) and the states to bring all *Publicly Owned Treatment Works (POTWs)* into compliance with *Clean Water Act (CWA)* requirements.

National Ocean Service (NOS) [NOAA] — As the nation's principal advocate for coastal and ocean stewardship, the NOS develops the national foundation for coastal and ocean science, management, response, restoration, and navigation. The NOS, which is a part of the *National Oceanic and Atmospheric Administration (NOAA)*, U.S. Department of Commerce, maintains its leadership role in coastal stewardship by bridging the gap between science, management, and public policy in the following areas:

- [1] **Healthy Coasts** — The North American coastline offers immeasurable wealth and an abundance of natural resources. However, ocean and freshwater coastal areas are constantly changing because of natural and human forces. U.S. coastal areas are magnets for a wide array of commercial, recreational, residential, industrial, and transportation uses. Pressures from these activities can harm or destroy valuable and sometimes irreplaceable resources. The NOS, through research, response to coastal threats, restoration of damaged areas, and management of coastal resources works to achieve balance in the coastal zone for this and future generations.
- [2] **Navigation** — Navigating ships and boats safely in and out of ports and along U.S. coasts is more difficult than most people realize. In many of our busiest ports, unknown rocks, wrecks, and obstructions silently wait below the surface to be discovered by unfortunate mariners. The NOS provides a wide-range of navigational products and up-to-the-minute data that help vessels safely move through U.S. waters. The NOS provides nautical charts, coastal surveys, and the National Spatial Reference System, a set of standard reference points that establish the latitude, longitude, and elevation framework for the nation's land surveying, navigation, positioning, and mapping activities.
- [3] **Coastal and Ocean Science** — Our oceans and coasts are places of mystery and wonder. They affect our weather, commerce, jobs, recreation, and where we build homes and locate businesses. They are an important source of food and energy. The coast is home to more than half of the U.S. population. The NOS is a leader in ocean and *Great Lakes* coastal science. Its activities include understanding and predicting impacts on sensitive habitats, studies of natural disasters, how climate change may affect our lives, and the investigation of the causes of harmful algal blooms and microbes, such as *Red Tides* and toxic *Pfiesteria piscicida*.
- [4] **Coastal Hazards** — Conditions such as a *Hurricane* and the powerful storm surges it brings, a *Tsunami* set into motion by an undersea earthquake, and beach erosion caused by the relentless pounding of the surf can be either natural events or natural disasters. The NOS provides communities with information about coastal hazards so they can better reduce or eliminate the destructive effects of natural events.

The following represent the principal operating divisions of the National Ocean Service:

- [1] **Office of Coast Survey** — Performs as the nation's nautical chartmaker. Signed into existence by President Thomas Jefferson in 1807, the Coast Survey is the oldest U.S. scientific organization and has a long history of supporting marine commerce. Its products include the national suite of nautical charts and related information which support commercial shipping, the fishing industry, U.S. Naval and Coast Guard operations, state and local governments, and recreational boaters throughout the United States.
- [2] **Office of National Geodetic Survey (NGS)** — Develops and maintains the National Spatial Reference System (NSRS) using advanced geodetic, photogrammetric, and remote sensing techniques. NSRS is a consistent national coordinate system that defines latitude, longitude, height, scale, gravity, and orientation, and how these values change with time, across the United States. This information is essential to support public safety, coastal stewardship, economic prosperity, and environmental well being. It ensures the reliability of transportation, navigation, communication, defense systems, boundary and property surveys, land record systems, mapping and charting, public utilities, coastal zone management, natural resource mapping, and a multitude of scientific and engineering applications.
- [3] **Office of Ocean and Coastal Resource Management (OCRM)** — The nation's coastal and ocean areas represent its most ecologically and economically important regions. Congress recognized this in 1972 when it passed the Coastal Zone Management Act (CZMA) and the National Marine Sanctuaries Act (NMSA). The CZMA created a partnership between the NOS OCRM and state and territorial governments. Day-to-day management decisions are made at the state level in some 33 state Coastal Zone Management Programs and 25 individual National Estuarine Research Reserves (NERRS). These programs attempt to balance competing demands on coastal land and water resources within the coastal zone, such as habitat protection, coastal hazard mitigation, public access, and development. Toward this aim, the programs seek results that provide the greatest overall benefit for coastal and ocean resources.
- [4] **Office of Response and Restoration** — Addresses the full range of responsibilities delegated to NOAA by the Department of Commerce for preventing and mitigating risks to coastal habitats and resources from oil and hazardous materials releases. It is the focal point within NOAA for responding to oil and hazardous materials releases and provides the primary scientific support to the lead cleanup entity (known as the "Unified Command") for spills occurring in U.S. coastal and navigable waters. The Office has been delegated trustee responsibilities assigned to the Secretary of Commerce under the Clean Water Act (CWA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Oil Pollution Act (OPA).
- [5] **National Centers for Coastal Ocean Science (NCCOS)** — Conducts and supports research, monitoring, assessment, and technical assistance for the range of NOAA's coastal missions. NCCOS is comprised of five individual Centers:

(a) The Center for Sponsored Coastal Ocean Research contains the Coastal Ocean Program and manages NOAA's involvement in the National Oceanographic Partnership Program. Research in these programs focuses on coastal ecosystem oceanography, cumulative coastal impacts, coastal forecasting, natural hazards, harmful algal blooms, coastal and ocean observation and prediction, data access and delivery, and marine education; (b) The Center for Coastal Monitoring and Assessment provides long-term measurements at a network of core index sites (including NOAA's marine protected areas), and is augmented by a network of sites in partnership with marine labs and universities; (c) The Center for Coastal Environmental Health and Biomolecular Research provides scientific information required to resolve important issues related to the health of coastal ecosystems; (d) The Oxford Cooperative Lab specializes in shellfish pathology and habitat restoration research; (e) The Center for Coastal Fisheries Habitat Research studies the biological productivity of estuaries and ocean ecosystems to enhance recreational and commercial fishery resources.

National Oceanic and Atmospheric Administration (NOAA) — An agency of the U.S. Department of Commerce, the National Oceanic and Atmospheric Administration was formed in 1970, but its origins may actually be traced as far back as 1807 when President Thomas Jefferson ordered a survey of the new nation's coastline. Today, NOAA has translated the United States' geographic, atmospheric, oceanic, and meteorological informational needs into an organization concentrating in the following principal areas:

- [1] **Research and Analysis** — NOAA researchers and scientists in the areas of oceanography, meteorology, biology, and physics explore the sea and air for new clues aimed at understanding or reversing environmental damage such as ozone depletion, the greenhouse effect, and possible global warming;
- [2] **Satellite Imaging and Mapping** — NOAA's satellites provide essential information for accurate weather forecasts, monitor winter snowpack conditions across the country, and gauge the health of coastal estuaries;
- [3] **Data Compilation and Dissemination** — The results of NOAA's data collection, satellite mapping, and research and analysis affords vast stores of information in NOAA's global data centers available for climate, oceanographic and geophysical reports vital to the public and industry;
- [4] **Forecasting and Weather Warning** — Through the *National Weather Service (NWS)*, NOAA provides extensive information and warnings when severe weather threatens life and property.

The National Oceanic and Atmospheric Administration consists of a number of separate agencies to effect these research, analysis, monitoring, informational, and forecasting requirements.

- [1] **National Weather Service (NWS)** — The National Weather Service operates a vast network of automated weather stations around the nation equipped with sophisticated doppler radar systems on the ground as well as sophisticated satellites providing detailed imaging which provide meteorologists and citizens early warnings of severe weather conditions. In cooperation with the Federal Aviation Administration (FAA), the NWS is proceeding with establishing some 1,000 fully automated weather data collection sites, termed *Automated Surface Observing Systems (ASOS)*.
- [2] **National Ocean Service (NOS)** — The National Ocean Service charts and surveys America's coastal waterways, providing safe passage for commerce and recreation interests. The NOS also plays a major role in managing America's coastlines and NOAA's *Coastal Zone Management Program* strives to protect wetlands, water quality, beaches, wildlife, and other important resources and uses of our coasts. As part of the NOS, NOAA's *National Marine Sanctuaries*, the nation's underwater national parks, provide unique undersea preserves to protect important coastal resources. The NOS monitors the health of the coast and probes how our use of the nation's nearshore waters affects the environment.
- [3] **National Environmental Satellite, Data and Information Service (NESDIS)** — The NESDIS operates the world's largest environmental data storage and distribution facility providing extensive and highly detailed data on weather, the oceans and geophysics. The NESDIS is also responsible for NOAA's polar orbiting and geostationary satellites which provide important information on the oceans and atmosphere. Other NESDIS satellites collect images of cloud and storm patterns which are then relayed to NOAA's National Weather Service and are extensively used by the nation's meteorologists for local weather reporting and forecasting.
- [4] **National Marine Fisheries Service (NMFS)** — The NMFS serves as steward for America's living marine resources, conducting research necessary to manage these valuable resources and enforces fishery regulations, maintains the wholesomeness of U.S. seafood products, and protects coastal fishery habitats and nurseries. The NMFS manages the 32 federal fishery resource plans, covering more than 230 species, and plays a key role in protecting coastal habitats, marine mammals and endangered and threatened species per the *Endangered Species Act (ESA)*.
- [5] **Office of Oceanic and Atmospheric Research** — NOAA's scientists conduct leading edge research on weather, climate, air quality, the oceans and the Great Lakes through a network of environmental laboratories and monitoring stations as well as through university researchers supported by NOAA through the *National Sea Grant College Program* and the *National Undersea Research Program*.
- [6] **NOAA Corps** — NOAA also operates the nation's smallest uniformed service consisting of some 400 officers commanding NOAA's fleet of hurricane hunter aircraft and environmental research ships providing in a variety of scientific and research operations.

National Oil and Hazardous Substances Pollution Contingency Plan [EPA] — More commonly called the National Contingency Plan (NCP), represents the federal government's blueprint for responding to both oil spills and hazardous substance releases. This national response capability plan promotes the overall coordination among a hierarchy of responders and contingency plans.

National Park — An area of unusual scenic or historic interest owned by the federal government and administered by the National Park Service, U.S. Department of the Interior, to conserve the scenery, the flora and fauna, and any natural and historical objects within its boundaries for public enjoyment in perpetuity.

National Pollutant Discharge Elimination System (NPDES) [EPA] — The program established by the *Clean Water Act (CWA)* that requires all *Point Sources (PS)* of pollution discharging into any “waters of the United States” to obtain a permit issued by the *U.S. Environmental Protection Agency (EPA)* or a state agency authorized by the federal agency. The NPDES permit lists permissible discharges and/or the level of cleanup technology required for wastewater.

National Pollutant Discharge Elimination System (NPDES) Permit [EPA] — The regulatory agency document issued by either a federal or state agency which is designed to control all discharges of pollutants from point sources in U.S. waterways. NPDES permits regulate discharges into navigable waters from all point sources of pollution, including industries, municipal treatment plants, large agricultural feed lots and return Irrigation flows.

National Primary Drinking Water Regulations (NPDWR) [EPA] — (1) Federal enforceable standards to protect public health, to the extent feasible, using technology, treatment techniques, and other means, which the administrator of the EPA determined as generally available. (2) Regulations for public drinking water supply systems that include health-based standards for various contaminants, and monitoring and analysis requirements. Issued by the *U.S. Environmental Protection Agency (EPA)* under authority of the *Safe Drinking Water Act (SDWA)*. While the NPDWR set standards protective of the public health, the *National Secondary Drinking Water Regulations (NSDWR)* set aesthetic standards for drinking water, i.e., color, odor, taste, etc. Also see *Drinking Water Standards*, *Drinking Water Standards [Nevada]*, *Maximum Contaminant Level (MCL)*, and *Maximum Contaminant Level Goal (MCLG)*.

National Priorities List (NPL) [EPA] — A list of the hazardous waste disposal sites most in need of cleanup. The list is updated annually by the *U.S. Environmental Protection Agency (EPA)* based primarily on how a site scores using the *Hazard Ranking System*. A site must be on the NPL to receive money from the trust fund for remedial action. Also referred to as the *Superfund List*.

National Reclamation Act — See *Reclamation Act*.

National Response Center (NRC) — The U.S. Coast Guard unit that receives reports of hazardous chemical spills and is responsible for notifying other agencies which will help plan, coordinate, and respond to the release.

National Response Team (NRT) — An organization of the federal government under the leadership of the *U.S. Environmental Protection Agency (EPA)* that includes representatives of 10 other federal agencies. The team serves as an umbrella organization at the federal level, and its functions include, among others, evaluating methods to respond to discharges or releases; recommending needed changes in the response organization; making recommendations relative to the training, equipping, and protection of response teams; evaluating response capabilities; reviewing regional responses to discharges; and coordinating the activities of federal, state, and local governments as well as private organizations in response to discharges.

National Rural Water Association (NRWA) — The mission of the National Rural Water Association is “to provide its affiliated state associations with the highest quality of support services designed to assist them in meeting the needs of their utility membership.” In terms of water and wastewater utility support, the National Rural Water Association is a non-profit federation of State Rural Water Associations. Their mission is to provide support services to their state associations who have more than 20,000 water and wastewater systems as members. Member state associations are supported by their water and wastewater utility membership and offer a variety of state specific programs, services, and member benefits. Additionally, each state association provides training programs and on-site assistance in areas of operation, maintenance, finance, and governance. Whether an association needs help developing a new rate schedule, setting up proper testing methods, maintaining or upgrading its operator license, or even understanding the ever-changing and complex governmental regulations, contact your state rural water association for available services and find out how membership can benefit you and your utility. NRWA’s state associations have historically trained over 40,000 water and wastewater system personnel a year for two decades and provided over 60,000 on-site technical assistance visits a year. Over 2,600 groundwater protection plans have been adopted by local communities, and another 2,300 are in the process of being adopted.

National Secondary Drinking Water Regulations (NSDWR) — (1) Standards set based on aesthetic quality of drinking water and are not federally enforceable. (2) Regulations governing the operation of public water supply systems under the *Safe Drinking Water Act (SDWA)*. The regulations define secondary maximum contaminant levels, the maximum concentrations of certain substances in drinking water that affect its aesthetic quality. While the NSDWR set aesthetic standards for drinking water, i.e., color, odor, taste, etc., the *National Primary Drinking Water Regulations (NPDWR)* set standards protective of the public health.

National Spatial Reference System (NSRS) — See *National Geodetic Survey (NGS) [NOAA]*.

National Stream Quality Accounting Network (NASQAN) — A data system operated by the *U.S. Geological Survey (USGS)* that compiles measurements of water pollutants concentrations taken at the downstream ends of all major water basins in the United States.

National Strike Force (NSF) — An organization under the leadership of the U.S. Coast Guard that responds to spills of oil or hazardous substances in waters of the United States. The NSF operates through various teams organized in different regions of the country. They provide, among other services, communications support, advice, and assistance in the event of discharges; shipboard damage control; containment and removal of discharges; and diving activities related to damage assessment and surveys.

National Water and Climate Center (NWCC) [NRCS] — An agency of the *Natural Resources Conservation Service (NRCS)*, U.S. Department of Agriculture (USDA), the mission of the National Water and Climate Center (NWCC) is to lead in the development and transfer of water and climate information and technology which support natural resource conservation measures. The NWCC views itself as becoming a globally recognized source of quality spatial snow, water, climate, and hydrologic network of

information and technology. The main office of the NWCC is located in Portland, Oregon, while some NWCC personnel are also located at NRCS offices in Amherst, Massachusetts. The primary functions of the NWCC are:

[1] **Natural Resource Planning Support:**

- Provide water and climate technology support for the Field Office Computing System (FOCS);
- Assess the effectiveness of applied technology and support activities in meeting customer needs;
- Provide water supply forecasts;
- Provide water and climate analysis, information, and services for NRCS and others;
- Provide concepts and technical input for policy development and legislation;
- Provide emergency support in response to extreme natural resource events;
- Provide water quality and quantity expertise for farm, field, watershed, and river basin evaluations;

[2] **Data Acquisition and Management:**

- Operate the Snowpack Telemetry (SNOTEL) data collection system;
- Operate the Soil Moisture/Soil Temperature Pilot Project (SM/STPP);
- Acquire, enhance, and manage specific data for resource planning;
- Design and manage databases for NRCS and others for farm, watershed and river basin planning;
- Design and manage air and water databases to support the Field Office Computer System (FOCS);
- Coordinate in developing the integration of plant, animal, soil, water quality, and pesticide databases.

[3] **Technology Innovation:**

- Identify priority needs to support the Field Office Technical Guide (FOTG);
- Assess and select technologies required to address resource concerns;
- Facilitate and adapt new and appropriate technologies;
- Maintain an inventory of available and developing technologies.

[4] **Partnerships and Joint Ventures:**

- Cooperatively fund, develop, and share new technology;
- Establish and maintain joint strategic databases;
- Develop cooperative support for technology transfer and implementation;
- Partner with NRCS and other organizations for natural resource planning support;

[5] **Technology Transfer:**

- Release new technology through means appropriate to user needs;
- Provide expertise and assist in training related to new technological releases and transfers;
- Market and promote new technology.

National Water Program [EPA] — The U.S. Environmental Protection Agency (EPA) Office of Water is responsible for carrying out the National Water Program for the United States. This program has core statutory authority in crucial environmental legislation to include the *Clean Water Act (CWA)*, *Safe Drinking Water Act (SDWA)*, the *Marine Protection, Research, and Sanctuaries Act*, and amendments to these legislative mandates. Major emphasis of this program includes four distinct parts:

- [1] **Clean Water** — The Clean Water Act authorizes an essential set of core programs that are the foundation for protecting and restoring the nation's water quality. Effluent guidelines provide minimum discharge standards for over fifty major industries. Water quality standards provide goals for water quality restoration and protection. The *National Pollution Discharge Elimination System (NPDES)* permitting process presently controls discharges from over 100,000 pollution sources. State and local pretreatment programs assure that facilities discharging to sewers provide appropriate levels of waste treatment. Revolving loan funds and grant programs in each state provide over \$2 billion in financing for water pollution control projects each year and have an overall value of over \$27 billion. The national wetlands program under Section 404 of the CWA is the primary defense system of the nation's critical wetland resources. The four key themes articulated in the Clean Water Action Plan provide the guidance for the clean water program today. These include:

- **Watershed Approach** — The Office of Water intends to build a new, cooperative effort to restore and sustain the health of rivers, lakes, coastal waters, and wetlands on a watershed basis;
- **Strong Federal, State, and Tribal Standards** — The action plan calls for improving state and tribal water quality standards intended to protect public health, prevent polluted runoff, and ensure accountability;
- **Natural Resources Stewardship** — Clean water depends on the conservation and stewardship of crop and pasture lands, rangelands, and forests that are in private and public hands; cooperation among federal natural resource agencies is recognized as being essential to this effort; and
- **Informed Citizens and Officials** — Accurate and timely information about the health of the nation's watersheds, beaches, fish species, and drinking water is the foundation of a sound and accountable clean water program.

- [2] **Safe Drinking Water** — The Safe Drinking Water Act and its amendments have provided both the impetus for substantial changes to the nation's drinking water program for EPA, states, tribes, and water utilities, and have also provided greater protection and information to the American public served by *Public Water Supply Systems (PWWS)*. Legislative changes have set the course for the drinking water community (i.e., EPA, states, Indian tribes, water

utilities) to prepare for and address future drinking water safety challenges and assure the sustainable availability of safe drinking water. Four themes provide a balanced, integrated framework and provide the EPA's national commitment to protect public health:

- The Public's Right to Know – SDWA amendments have greatly increased the ability of the public to learn about and actively participate in drinking water protection decisions;
 - Focusing on Contaminants of Greatest Risk – Amendments emphasize the need for sound science and accurate data to identify the most harmful contaminants and support the EPA's regulatory decisions;
 - Funding and Tools for States and Water Systems – Funding from loans and set-asides in the Drinking Water State Revolving Loan Fund (DWSRF) have allowed states and water systems to improve their ability to provide safe drinking water by upgrading, renovating, and modernizing their infrastructure. EPA has also developed many tools that increase states' flexibility in implementing health-based and program-related regulations;
 - Pollution Prevention – A major theme of the SDWA amendments has been the prevention of contamination of surface and groundwater resources that serve as drinking water supplies. Through source water protection (e.g., wellhead protection programs), the EPA has made prevention the first step in the multiple barrier approach to drinking water protection.
- [3] ***Building for the Future*** – The Clean Water Action Plan and the SDWA amendments provide the National Water Program with a myriad and challenging list of required actions. Long-term goals of this water protection program include:
- Improving Information About the Condition of Waters – Fulfilling the public's right-to-know about environmental conditions and related risks is an integral part of the Office of Water's mission. The EPA is making a major commitment to redesign its internal management structure to better meet the information demands of the 21st century and provide information necessary to improve and protect the nation's water resources;
 - Assuring Adequate Funding for Clean and Safe Water – The enactment of the CWA formed the catalyst for federal, state, tribal, and local government partnerships for the financing of water pollution control projects. These partnerships have resulted in dramatic increases in water pollution control and dramatic improvements in water quality. State clean water revolving loan funds have formed the foundation of this financial partnership. There is a growing recognition that other federal and state programs (e.g. buffers, land preservation) contribute to water pollution control and the EPA's new watershed approach has created opportunities to engage other programs as well;
 - Strengthening Protection of Estuarine and Coastal Waters – The EPA considers coastal waters to be an important ecological, recreational, and economic resource – fifty percent of the population lives in coastal watersheds and coasts are the most common vacation destination. But the coasts are under severe pressure from development and related water pollution problems. Many coastal waters are impaired by water pollution and need prompt attention. In addition, some of the nation's most treasured and fragile marine resources, such as coral reefs, are at risk. The Clean Water Action Plan outlines important steps to protect coasts and coastal environments.
- [4] ***Accounting to Congress and the American Public*** – The EPA's Office of Water recognizes that it must be accountable to the Congress and to the American public for making necessary environmental progress and therefore fully intends to be results oriented in carrying out its necessary responsibilities.

National Water Resources Research Institute Program [USDI] — See *National Institutes for Water Resources (NIWR) [USDI]*.

National Weather Service (NWS) [NOAA] — An agency of the (U.S. Department of Commerce) *National Oceanic and Atmospheric Administration (NOAA)*, the primary mission of the National Weather Service is to protect life and property and enhance the nation's economy by providing warnings and forecasts of hazardous weather, including thunderstorms, flooding, hurricanes, tornadoes, winter weather, and tsunamis. The primary customer of the NWS is the private weather industry whose meteorologists receive data and information directly from the NWS and incorporate it into local news reports. The NWS also operates its own radio network; the *NOAA Weather Radio* is the sole government radio system providing direct warnings of hazardous weather conditions and natural disasters to private citizens through a network of 390 transmitters across the nation. The NWS provides short and long-range forecasts, severe weather warnings, and atmospheric data continually to private weather vendors for a fee using a telephone data transmittal system called *Family of Services*. NWS Doppler radar data is provided through the NWS *NEXRAD Information Dissemination Service (NIDS)* and is available from commercial weather vendors under an agreement with the NWS. The *NOAA Weather Wire Service* is the primary NWS telecommunications network for NWS forecasts, warnings, and other products to the mass media (TV, radio, newspaper) and emergency management agencies. It consists of a satellite communications system operated under contract by GTE/Contel. In a joint effort with the Federal Aviation Administration (FAA), some 250 NWS manual data collection field offices will be replaced with approximately 1,000 automated data collections sites, termed *Automated Surface Observing Systems (ASOS)*, thereby greatly enhancing both the timeliness and frequency of the NWS weather reporting capabilities.

National Wetlands Inventory (NWI) [USFWS] — The National Wetlands Inventory of the *U.S. Fish & Wildlife Service (USFWS)* produces information on the characteristics, extent, and status of the nation's wetlands and deepwater habitats. The National Wetlands Inventory Center's (NWIC) repository of wetland information is used extensively by federal, state, and local agencies, academic institutions, the U.S. Congress, and the private sector. The NWIC has mapped 90 percent of the lower 48 states, and

34 percent of Alaska. About 44 percent of the lower 48 states, and 13 percent of Alaska have been digitized for electronic use. Congressional mandates require the NWIC to produce status and trends reports to Congress at ten-year intervals. In 1982, the NWI produced the first comprehensive and statistically valid estimate of the status of the nation's wetlands and wetland losses, and in 1990 produced the first update. Future national updates scheduled for 2000, 2010, and 2020. In addition to wetland status and trend reports, the NWIC has produced over 130 publications, including manuals, plant and hydric soils lists, field guides, posters, wall size resource maps, atlases, state reports, and numerous articles published in professional journals. The NWIC is located in Saint Petersburg, Florida, and by using state-of-the-art computer systems it is able to construct the wetlands layer of the National Spatial Data Infrastructure (NSDI). Digitized wetlands data can be integrated with other layers of the NSDI such as natural resources and cultural and physical features, leading to production of selected color and customized maps of the information from wetland maps, and the transfer of digital (computer-readable) data to users and researchers world-wide. NWI maps and digital data are distributed widely throughout the country and the world.

National Wetlands Research Center (NWRC) [USGS] — The mission of the National Wetlands Research Center is to develop and disseminate scientific information needed for understanding the ecology and values of our nation's wetlands and for managing and restoring wetland habitats and associated plant and animal communities. The NWRC is a source and clearinghouse of science information about wetlands in the United States and the world for fellow agencies, private entities, academia, and the public at large. Staff members obtain and provide this information by performing original scientific research and developing research results into literature and technological tools. NWRC research includes a broad array of projects on wetland ecology, values, management, restoration and creation, plus research on the ecology of a wide variety of plant and animal species and communities that are found in wetlands. NWRC's research focuses on estuarine, marine, and freshwater wetlands. Along the coasts, the NWRC works on issues related to marine seagrasses and corals, estuarine waters, marshes and submerged aquatic vegetation, mangrove swamps, and freshwater areas of open water, marshes, submerged vegetation, forests and coastal prairies. Farther inland the NWRC has work underway on forested wetlands, including bottomland hardwoods, cypress-tupelo swamps, and pine savannahs. The NWRC also develops technologies that will aid natural resource managers (state, federal, and private) in determining the status and trends of wetland habitats. These technologies include remote sensing, geographic information systems, and computer models that simulate the influence of environmental change and management activities on wetlands. The NWRC had its beginnings in the National Coastal Ecosystems Team, founded in 1975 as part of the *U.S. Fish and Wildlife Service's (USFWS)* Office of Biological Services. In 1993 the Secretary of the Interior consolidated research in several bureaus of the Department of the Interior to form the National Biological Survey, an agency designed to foster scientific understanding and technologies. In 1995 the National Biological Survey became the National Biological Service and in 1996 the National Biological Service became the Biological Resources Division of the *U.S. Geological Survey (USGS)*. The NWRC is one of 16 science centers of the Biological Resources Division. Studies take place throughout the Southeast, Texas, and Mexico. Current field stations and project offices are located in Florida, Texas, and Louisiana. The NWRC has three scientific branches and support functions as follows: (1) Forest Ecology Branch; (2) Spatial Analysis Branch; (3) Wetlands Ecology Branch; (4) Technology and Informatics Branch; and (4) Administrative Office.

National Wilderness Preservation System — All lands covered by the *Wilderness Act* of 1964 and subsequent wilderness designations, irrespective of the department or agency having jurisdiction.

National Wildlife Refuge (NWR) System — The mission of the National Wildlife Refuge System is to provide, preserve, restore, and manage a national network of lands and waters sufficient in size, diversity, and location to meet society's needs for areas where the widest possible spectrum of benefits associated with wildlife and wildlands is enhanced and made available. The system comprises a unique and diverse network of over 92 million acres of lands and waters in the United States. This system spans the continent from the north coast of Alaska to the Florida Keys and beyond to tropical islands in the Caribbean and Central Pacific. Over 500 national wildlife refuges are included in the Refuge System. They are managed by the Department of the Interior, *U.S. Fish and Wildlife Service (USFWS)* for the conservation and enhancement of fish and wildlife and their habitats. Refuges may range in size from Minnesota's tiny Mille Lacs (less than an acre) to Alaska's sprawling Yukon Delta (almost 20 million acres). Refuges provide habitat — food, water, shelter, and space — for more than 60 endangered species and hundreds of other species of birds, mammals, reptiles, amphibians, fish, and plants. The first national wildlife refuge was Florida's Pelican Island, established in 1903 by President Theodore Roosevelt to protect egrets, herons, and other birds that were being killed for feathers used in the fashions of the time. Also see *National Wildlife Refuges [Nevada]*.

National Wildlife Refuges (NWR) [Nevada] — There are currently nine *National Wildlife Refuges (NWR)* in the State of Nevada, including the largest refuge located within the 48 contiguous states — the Desert National Wildlife Refuge. One wildlife refuge — the Sheldon National Wildlife Refuge — is contained mostly in Nevada with a small portion of its northern tip extending up into the State of Oregon. Nevada's National Wildlife Refuges, all of which are managed by the *U.S. Fish and Wildlife Service (USFWS)*, include:

- [1] **Anaho Island National Wildlife Refuge** — Established in 1913 by President Woodrow Wilson to protect the white pelican nesting colonies, the Anaho NWR consists of the 750-acre (1.2 square mile) Anaho Island in Pyramid Lake, which is wholly contained within the Pyramid Lake Paiute Indian Reservation. Located approximately 45 northeast of Reno, Nevada, the Anaho NWR contains one of the largest white pelican nesting colonies in North America, as well as cormorant, great blue heron, and gull nesting colonies. This refuge is closed to the public for the protection of the colony nesting birds.
- [2] **Ash Meadows National Wildlife Refuge** — Located approximately 90 miles northwest of Las Vegas in Nye County, Nevada, the Ash Meadows NWR, established in 1984, encompasses some 14,000 acres (approximately 22 square miles) and provides critical habitat for 25 plant and animal species found nowhere else in the world. This distinguishes the Ash Meadows NWR as having the greatest concentration of endemic species of any other local area

in the United States. Of the 25 unique species, 12 have been listed as either *Threatened* or *Endangered*. Water is the key natural resource which makes the Ash Meadows NWR a unique *Ecosystem* in the dry Mojave Desert. In this area, water-bearing strata come to the surface in approximately 30 seeps and springs, providing a rich and complex variety of habitat. The earliest efforts to protect this area were undertaken by *The Nature Conservancy*, which purchased 12,613 acres of land in 1984 and subsequently sold it to the USFWS specifically to establish a wildlife refuge.

- [3] **Desert National Wildlife Refuge** – Established in 1936, the Desert NWR covers 1,588,459 acres (2,482 square miles) of the diverse Mohave Desert in southern Nevada and is the largest National Wildlife Refuge in the 48 contiguous United States. The Desert NWR's most important objective is the perpetuation of the desert bighorn sheep and its habitat. The refuge contains six major mountain ranges, the highest rising from a 2,500 foot elevation valley floor to nearly 10,000 feet. The dry climate and varying elevations provide varied plant life with creosote bush and white bursage dominant in the lower elevations, Mojave yucca and cactus dominant in the mid-elevations, blackbrush and Joshua trees prevalent near 6,000 feet, and single-leaf pinyon and Utah juniper become prominent at 6,000 feet. From 7,000–9,000 feet Ponderosa pine and white fir become dominant and near 10,000 feet the only remaining tree is the bristlecone pine. Throughout this area the big sagebrush is the most common shrub. Within this refuge, and in stark contrast to the typical habitat and wildlife prevalent throughout the refuge, are the numerous and diverse plant and animal communities at Corn Creek. Here springs turn the desert into an oasis attracting over 200 species of birds alone.
- [4] **Fallon National Wildlife Refuge** – Established in 1931, the Fallon NWR encompasses approximately 17,900 acres (28 square miles) where the Carson River terminates in the Carson Sink and is situated within the northwest portion of the *Stillwater Wildlife Management Area*. Due to typically limited and uncertain flows of the Carson River at its terminus, generally not enough water enters this refuge to maintain it as a viable wetlands. The area is currently managed by the USFWS along with the *Stillwater National Wildlife Refuge* and is included as part of the Stillwater Wildlife Management Area.
- [5] **Moapa National Wildlife Refuge** – The Moapa NWR was established in 1979 in order to protect and secure habitat for the Endangered Moapa dace and a candidate for listing, the White River springfish. The refuge contains 32 acres (0.05 square mile) and is located just north of the Moapa River Indian Reservation, 5 miles northwest of Moapa, Nevada, located in Clark County.
- [6] **Pahranagat National Wildlife Refuge** – Located approximately 90 miles north of Las Vegas, Nevada, the Pahranagat NWR is located at the northern end of the Desert NWR and consists of 5,380 acres (8.4 square miles) of marshes, open water, native grass meadows and cultivated croplands. Established in 1964, the Pahranagat NWR hosts numerous waterfowl and other migratory birds on the Pacific Flyway, which stretches from Alaska and Canada to Mexico. The name “Pahranagat” comes from the Paiute Indian word meaning “place of many waters.”
- [7] **Ruby Lake National Wildlife Refuge** – This NWR, which was established in 1938, covers an area of 37,632 acres (58.8 square miles) consisting of marshes, open ponds and islands, bordered by wet meadows and grass/sagebrush-covered uplands. The Ruby Lake NWR, which collects the waters from over 160 springs along the base of the Ruby Mountains, lies within a closed drainage basin in Ruby Valley of northeastern Nevada approximately 65 miles southeast of the town of Elko along the eastern flank of the rugged and scenic Ruby Mountains at an elevation of 6,000 feet above sea level. During the Pleistocene Epoch, the Ruby Marshes were part of a much larger body of water known as Franklin Lake, an Ice Age lake which covered some 470 square miles and was over 200 feet deep; however, today, only the Ruby and Franklin Lake marshes remain and provide an important refuge to nesting and migratory waterfowl and water birds using the migration corridors of both the Pacific and Central Flyways.
- [8] **Sheldon National Wildlife Refuge** – Located in the northwestern corner of Nevada, the Sheldon NWR manages over 575,000 acres (approximately 900 square miles) of high-desert habitat as a representative area for native plants and wildlife. The Sheldon NWR was formally established in 1978 and represented a consolidation of two refuge and range protection areas: (1) the Charles Sheldon Wildlife Range, created in 1931 by President Herbert Hoover from the purchase of the 30,000-acre Last Chance Ranch by the Boone and Crockett Club and the National Audubon Society; and (2) the Charles Sheldon Antelope Range, an area of over one-half million acres created in 1936 by President Franklin D. Roosevelt for the conservation and development of natural wildlife resources. Today, this area encompasses remote settings, scenic vistas, numerous natural geothermal hot springs, old ranches and homesteads plus sites of archaeological significance. Some 20 million years ago this area was covered with pine forests and lush grasslands, nurtured by a mild climate and more than 50 inches of annual rainfall. Today, this area receives only from 4–8 inches of precipitation, primarily in the form of snowfall, and the prominent geological characteristic of this refuge is the subsequent volcanic activity which spewed rhyolitic magma over much of its area with basalt flows up to 100 feet thick. These have formed the large, broad tables prevalent in this area today.
- [9] **Stillwater National Wildlife Refuge** – Located approximately 15 miles east of Fallon, Nevada within Churchill County on the edge of the Carson Sink, the Stillwater NWR was formally established in 1991 when 77,500 acres (121 square miles) of the *Stillwater Wildlife Management Area* were set aside to preserve critical nesting and habitat for migratory waterfowl and other birds using the Pacific Flyway in western Nevada. In 1948, in order to preserve a shrinking wetland system, the U.S. Fish and Wildlife Service and the Nevada Fish and Game Commission entered into an agreement with the *Truckee–Carson Irrigation District (TCID)* to develop and manage 224,000 acres (350 square miles) of *U.S. Bureau of Reclamation (USBR)–Newlands (Irrigation) Project* lands, designated as the Stillwater Wildlife Management Area, for wildlife habitat protection and preservation. Today, the Stillwater NWR

includes a variety of habitats, from freshwater sloughs and marshes to brackish-water marshes and alkali flats. Each habitat hosts a unique assemblage of plants and invertebrates, which in turn attracts more than 160 bird species and many other animals.

Native Species — A species that is a part of an area's original fauna or flora.

Natron Lake — See *Soda Lake*.

Natural Attenuation — The process of *Microbiological Anaerobic Degradation* in which hazardous wastes and toxic compounds are treated while not involving the addition of foreign microbes to the site but rather using naturally-occurring microbes already present. Also see *Attenuation*.

Natural Conditions — Conditions under which hydrologic processes and variables are not affected by man. For water budgets, such conditions commonly are assumed to represent long-term, steady state conditions.

Natural Control — A stream-gaging control which is natural to the stream channel, in contrast to an artificial control constructed by man.

Natural Cycles — Cycles that take place in nature such as the water or *Hydrologic Cycle* where water is transformed or changed from one form to another until the water has returned to the original form, thus completing the cycle. Other natural cycles include the life cycles of aquatic organisms and plants, nutrient cycles, and cycles of self-purification or natural purification.

Natural Erosion — Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of climates and vegetation. Also see *Erosion*.

Natural Flow — (1) Flows, typically in river system, that are not placed into the system by man-made activities. (2) The rate of water movement past a specified point on a natural stream from a drainage area for which there have been no effects caused by stream diversion, storage, import, export, return flow, or change in *Consumptive Use* caused by man-controlled modification to land use. Natural flow rarely occurs in a developed county.

Natural Heritage Program [Nevada] — As a statewide program, the Nevada Natural Heritage Program serves as a centralized repository containing detailed and computer-retrievable information on sensitive (threatened or endangered) species of animals, plants, and communities. Species information includes biology, habitats, locations, population and conservation status, and management needs.

Natural Load — A term for the amount of sediment transported by a stable stream.

Natural Logarithm (LN) — (Mathematics) The value of the exponent that the base, e , must have to equal a given number. It is calculated as $e^x = y$, where x is the logarithm. For example, the natural logarithm of 5 is the power (x) to which e (approximately equal to 2.718282) must be raised to equal 5, or $e^x = 5$, which is equivalent to approximately 1.60944. Also written as $\ln 5 = 1.60944$. Also see *Logarithm (Log)*.

Natural Organic Matter (NOM) — Humic substances composed of humic and fulvic acids that come from decayed vegetation.

Natural Precipitation — Represents the average annual precipitation (rainfall, snow, and sleet) measured at a number of different weather stations.

Natural Recharge — (1) Natural replenishment of an aquifer by precipitation, which percolates downward through soil and rock. (2) The replenishment of groundwater storage from naturally-occurring surface water supplies such as precipitation and stream flows. Also see *Artificial (or Induced) Recharge*, *Incidental Recharge*, and *Perennial Yield*.

Natural Resource — (Ecology) (1) Any material that exists in nature independently of human industry and that is somehow utilized by humans, such as water, petroleum, minerals, forests, fish, and wild game. (2) A material source of wealth, such as timber, fresh water, or a mineral deposit, that occurs in a natural state and has economic and/or value. Natural resources are considered *Nonrenewable* when they do not naturally replenish themselves within the limits of human time or *Renewable* when they are more or less continuously replenished in the course of natural events within the limits of human time.

(United States) Natural Resources Conservation Service (NRCS) [USDA] — Formerly known as the *Soil Conservation Service (SCS)*, an agency of the U.S. Department of Agriculture, the Natural Resources Conservation Service (NRCS) had its beginnings with a 1929 emergency act of Congress in response to the famous Dust Bowl when land practices, primarily in the Midwest Farm Belt, caused extensive soil erosion and threatened the food production of the United States. Initially, ten experiment stations were established to work with Land Grant Universities to study soil erosion and ways to prevent it. As a result of these initial efforts, the Soil Erosion Service was established in 1933 to show American farmers new ways of preventing and recovering from soil erosion. In 1935 Congress changed the Soil Erosion Service into the Soil Conservation Service and made it a permanent agency of the U.S. Department of Agriculture. In 1994 the name was change to Natural Resources Conservation Service to denote a broader role of responsibility in natural resource conservation. Presently, the NRCS works in three primary areas: (1) soil and water conservation; (2) resource inventories; and (3) rural community development. These activities are covered under a number of direct NRCS programs, involving only NRCS resources, and NRCS assisted programs, involving the NRCS and at least one other government agency.

Direct NRCS Programs:

- [1] Technical Assistance
- [2] Great Plains Conservation Program
- [3] Watershed Protection, Long-Term Contracts (Public Law 566)
- [4] USDA Compliance Plans

NRCS Assisted Programs:

- [1] Agriculture Conservation Program
- [2] Water Bank Program

- [3] Colorado River Salinity Control Program
- [4] Conservation Reserve Program
- [5] Water Quality Incentive Program
- [6] Emergency Conservation Program
- [7] Wetlands Reserve Program

Natural Resources Defense Council (NRDC) — A private American environmental organization emphasizing the proper management of natural resources. The NRDC has been an active participant in numerous precedent-setting lawsuits concerning national environmental policies.

Natural Selection — A process in nature resulting in the survival and perpetuation of only those forms of plant and animal life having certain favorable characteristics that enable them to adapt best to a specific environment.

Natural Sink — A habitat that serves to trap or immobilize chemicals such as plant nutrients, organic pollutants, or metal ions through natural processes. For example, a river that enters a swamp may carry a substantial amount of dissolved plant nutrients. The natural biological activity of the swamp may remove these nutrients to such an extent that the water exiting the swamp is relatively low in nutrient concentrations. The swamp has then served as a sink to trap the nutrients that are no longer available for subsequent plant growth downstream from the swamp. Also referred to as a *Nutrient Sink*.

Natural Substrate — Any naturally occurring immersed or submersed solid surface, such as a rock or tree, upon which an organism lives.

Naturally Developed Well — A well in which the screen is placed in direct contact with the aquifer materials; no filter pack is used.

Naturally Occurring Conservation — Conservation that results from plumbing code changes requiring the use of water-efficient plumbing fixtures, such as toilets, shower heads, etc.

[The] Nature Conservancy (TNC) — An international conservation organization incorporated in 1951 in the District of Columbia for scientific and education purposes. The mission of The Nature Conservancy is to preserve plants, animals and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive. Current resource conservation efforts cover Canada, the United States, Latin America, and the Caribbean. Through private donations, TNC purchases lands and then either retains ownership or transfers ownership for management to other conservation groups, both public and private. The following represent some notable facts and selected statistics about TNC and its accomplishments over the years:

- Acres protected by The Nature Conservancy in 1950's: 13,743;
- Acres protected by the TNC in 1990's: 7,120,338;
- Total acres protected by TNC in the United States: 12,089,000;
- Acres protected by the TNC outside the United States: 61,750,000;
- Current number of TNC preserves: 1,397;
- Size in acres of Niobrara Valley Preserve, TNC's largest: 55,823;
- Size in acres of Scotia Island Preserve, TNC's smallest: 0.5;
- Percentage of TNC's revenue dedicated to program expenses: 93;
- TNC employees in 2000: 2,821;
- TNC members in 1952: 554;
- TNC members in 2000: 1,029,012;
- Percentage of Earth's landmass needing protection to forestall a global extinction crisis, according to leading biodiversity expert Edward O. Wilson: 10;
- Percentage of Earth's landmass currently protected: 4;
- Number of large, landscape-scale Conservancy projects under way in 2000: 100;
- Number of large, landscape-scale Conservancy projects planned by end of this decade: 500.

Community-Based Conservation: A New Nature Conservancy Paradigm. Over the years, TNC has taken an entrepreneurial approach to conservation; one that encourages local ingenuity to address challenges that are unique to each site. Although the conservation programs implemented by each state cover the spectrum, one theme is common to most of the large, successful efforts – the needs of the local human community must be respected. TNC refers to this conservation concept as landscape-scale, community-based. The following are some characteristics of TNC's new paradigm for its conservation and preservation activities, i.e., landscape-scale, community-based conservation projects:

- Landscape-scale sites are those that support multiple plant and animal species and plant communities considered important conservation targets;
- A relatively large site, including both private and public lands, is required to not only capture the species and habitats of interest but the processes (e.g., fire, natural flooding cycles) necessary to sustain those conservation targets over the long term;
- Conservation of landscape-scale sites requires an ecosystem (versus single-species) approach that involves multiple strategies targeted at reducing the critical threats to the conservation targets, often by addressing incompatible development and human uses;
- Long-term site conservation requires building long-term local support that involves all key sectors of the human community;
- Development and implementation of the strategies to reduce the critical threats requires a long-term TNC commitment (i.e., 10 to 20 or more years);
- By addressing the needs of local stakeholders, TNC acts as a catalyst or program manager to build multi-lateral

- partnerships;
- Each landscape-scale site typically includes at least one significant TNC preserve that is used as a demonstration area for our conservation practices and serves as a platform for our work in the region;
- Implementation of the conservation strategies requires TNC staff living and working within the communities affected by our work;
- A relatively modest investment in local staff typically energizes the local community and generates major gifts of funding—both private and public—to support TNC’s actions at the site.

The Nature Conservancy and Conservation Science. TNC looks to science to guide its work. The success of TNC’s mission to protect plants, animals, and natural communities that represent the diversity of life on earth depends on a scientific understanding of the natural world and its myriad components. Science not only guides TNC’s work, it provides an anchor. TNC’s mission is ambitious and inspiring, and is driven by a vision for what could be. But it is also rational, the product of logical analysis. The combination of passion and reflection seals TNC’s pact with its members and other supporters. TNC is committed to use every available means to ensure success and constantly learn more about the world they are trying to save. Without the ability to use the tools of modern science to begin filling the many gaps in knowledge of how the natural world works, conservation would be a voyage without a map. Conservation in the 21st century demands that it use science in unprecedented ways. The Conservation Science Division of TNC facilitates this process by developing and testing conservation models and tools that directly effect on-the-ground conservation at sites. The Conservation Science Division provides methods, training, and technical support to Conservancy field staff and partners. The Division focuses on three core areas: (a) conservation planning at scales from sites to ecoregions; (2) ecological management and restoration; and (3) freshwater conservation. The Division also includes an applied research function focusing on emerging conservation issues. TNC is a leader in putting the latest conservation theories and concepts to the test. Its methods are credible, field-tested, and practical. It is felt that developing the best possible methods based on the best available science offers the greatest hope for lasting conservation success.

Naturopathy — A system of treatment of disease that avoids drugs and surgery and emphasizes the use of natural agents (as air, water, and sunshine) and physical means (as manipulation and electrical treatment).

Nauplius — The free-swimming microscopic larval stage characteristic of many crustaceans, barnacles, etc.

Nautical — Of, relating to, or characteristic of ships, shipping, sailors, or navigation on a body of water.

Nautical Mile — A unit of length used in sea and air navigation, based on the length of one minute of arc of a great circle, especially an international and U.S. unit equal to 1,852 meters (about 6,076 feet). Also called *Sea Mile*.

Navigable — Capable of being navigated; deep enough and wide enough to afford passage to vessels. In the United States, for the purpose of defining the rights of ownership, some states have adopted the common-law test of flow of the tide, others that of actual navigability. For determining the right of the public to the use of a body of water as a public highway, however, the test in the U.S. is as to whether the water is navigable in fact or not. And waters are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water. In truth, the law has a number of different and frequently confusing definitions of “navigable” rivers and lakes, although agreement exists that all tidal areas are considered navigable. For purposes of determining state title to the beds of rivers and lakes, they must have been capable of carrying commerce at the time the state entered the union. “Commerce” for this purpose includes more than boats carrying persons and cargo. The courts have found streams to be “navigable” where they have carried saw logs or shingle bolts. For purposes of some federal regulatory programs, a waterway must have carried, or be capable of carrying, interstate commerce. Other federal regulatory programs, for example, the *Federal Power Act*, include waterways which could carry interstate commerce with reasonable modifications. And finally, the *Clean Water Act (CWA)* defines “navigable” waters to include all waters of the United States which may affect or be affected by interstate commerce. Consequently, this encompasses most water bodies in the nation.

Navigable Waters — (1) Generally, those waters capable of supporting commerce. (2) The waters of the United States, including the territorial seas, and intrastate waters, which is any body of water with any connection to interstate waters or commerce and this includes virtually all surface water and wetlands. Despite its name, there is no requirement for vessels to be able to navigate these waters. Provisions of the *Clean Water Act (CWA)* apply to all such waters, including wetlands.

Navigable Waters of the United States [United States, 33 CFR 329.4] — “Navigable waters of the United States” are defined as those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions or events which impede or destroy navigable capacity.

Navigable Waters [Nevada] — In Nevada bodies of water are navigable if they are used, or are susceptible of being used, in their ordinary condition as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water. In Nevada, this test of navigability (*State of Nevada v. Julius Bunkowski, et al.*, 1972) held that the Carson River was navigable, and therefore the State of Nevada owned its bed, as logs were floated down the river from about 1860 to 1895 (the commerce requirement).

Navigate — (Nautical) To voyage over water in a boat or ship; to travel by water; sail.

Navigational Water Use — Water utilized as a means of commercial (and sometimes recreational) transportation. Includes water used to lift a vessel in a lock, or maintain a navigable channel level. Navigational water use is considered a non-consumptive instream use of water and is generally not measured or accounted for.

NBC — Nuclear, Biological, Chemical.

NCWS — See *Non-Community Water System*.

Neap Tide — (Oceanography) (1) A twice-monthly tide of minimal range that occurs when the earth, sun, and moon are at right angles to each other, decreasing the total tidal force exerted on the earth. (2) A tide that occurs when the difference between high

and low tide is least; the lowest level of high tide. Neap tide comes twice a month, in the first and third quarters of the moon. Contrast with *Spring Tide*.

Near the First Service Connection — At one of the 20 percent of all service connections in the entire system that are nearest the water supply treatment facility, as measured by water transport time within the distribution system.

Nearshore — (Oceanography) An indefinite area between the shoreline and the offshore zone beyond the breakers.

Nebraskan — (Geology) Of or relating to one of the glacial stages of the *Pleistocene* epoch which occurred in North America, which consisted of the *Nebraskan* (first stage), *Kansan* (second stage), *Illinoian* (third stage), and *Wisconsin* (fourth stage).

Neck — (Oceanography) The rip current proper, the long and narrow middle section of a rip current's length, where the current moves fastest.

Neck Cutoff — The breakthrough of a river across the narrow neck separating two meanders, where downstream migration of one has been slowed and the next meander upstream has overtaken it. Compare with *Chute Cutoff*. Also see *Oxbow*.

Needle — (1) A long, thin snow crystal that is at least five times longer than it is wide. (2) (Geology) A pointed, elevated, detached mass of rock formed by erosion.

Needle-Leaved Deciduous — Woody *Gymnosperms* (trees or shrubs) with needle-shaped or scale-like leaves that are shed during the cold or dry season; e.g., bald cypress (*Taxodium distichum*).

Needle-Leaved Evergreen — Woody *Gymnosperms* with green, needle-shaped, or scale-like leaves that are retained by plants throughout the year; e.g., black spruce (*Picea mariana*).

Negotiated Settlement (Public Law 101–618) [Nevada and California] — Omnibus legislation passed by the 101st Congress at the end of its 1990 session intended to settle a number of outstanding disputes concerning the Truckee and Carson Rivers. The legislation authorized an ambitious environmental restoration program to benefit the *Lahontan Valley Wetlands* and Pyramid Lake and the lower Truckee River. It also established a framework for resolving separate by closely-related water-resource conflicts involving the Pyramid Lake Paiute and Fallon Paiute–Shoshone Tribes, the cities of Reno and Sparks (Nevada), the states of Nevada and California, and (pending the resolution of several as-yet unsatisfied controversies) the *Newlands Project*. The legislation contains two primary titles: *TITLE I–The Fallon Paiute–Shoshone Indian Tribal Settlement Act*; and *TITLE II–The Truckee–Carson–Pyramid Lake Water Rights Settlement Act*. Collectively, the legislation can be referred to as the *Negotiated Settlement*. The seven (7) main elements covered by the legislation include:

- [1] **Promote the Enhancement and Recovery of Endangered and Threatened Fish Species** – A recovery program is to be developed for the Pyramid Lake endangered fish species cui-ui (*Chasmistes cujus*) and the threatened fish species Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) in compliance with the *Endangered Species Act (ESA)* and the Truckee–Carson–Pyramid Lake Water Rights Settlement Act. Water rights acquisitions are authorized for this purpose.
- [2] **Protect Wetlands from Further Degradation** – A water rights purchase program is authorized for *Lahontan Valley Wetlands*, with the intent of sustaining an average of 25,000 acres of wetlands (*Stillwater National Wildlife Refuge*: 14,000 acres; Carson Lake and Pasture: 10,200 acres; and Fallon Reservation and Indian Lakes: 800 acres) to both prevent further degradation and improve the habitat of the fish and wildlife which depend on those wetlands. The U.S. Fish and Wildlife Service (USFWS) has estimated that this will require up to 125,000 acre-feet (AF) of water per year.
- [3] **Encourage the Development of Solutions for Demands on Truckee River Waters** – An operating agreement is to be negotiated for the Truckee River – *The Truckee River Operating Agreement (TROA)* – covering procedures for using storage capacity in upstream reservoirs in California consistent with recovery objectives for listed Pyramid Lake fishes. This includes the implementation of the terms and conditions of the *Primary Settlement Agreement (PSA)* between SPPCo and the Pyramid Lake Paiute Tribe.
- [4] **Improve Management and Efficiency of the Newlands Project** – The Secretary of the Interior is authorized to operate and maintain the *Newlands Project* to serve additional purposes, including recreation, improved water quality flowing to the wetlands, improved fish and wildlife habitat, and municipal water supply for Lyon and Churchill counties. A project efficiency study is required. The 1973 Gesell Decision is recognized and the 1988 *Operating Criteria and Procedures (OCAP)* is to remain in effect at least through 1997.
- [5] **Fallon Paiute–Shoshone Water Issues Settlement** – Establishment of a settlement fund for the Fallon Paiute–Shoshone Tribe totaling \$43 million. The Tribe is authorized to purchase land and water rights to consolidate tribal holdings within the reservation. Specific litigation filed by the Tribe is to be dismissed.
- [6] **Pyramid Lake Paiute Tribe Issues Settlement** – A tribal economic development fund of \$40 million was established for the Pyramid Lake Paiute Indian Tribe to provide for the settlement of water, fish, and other issues. Another fund of \$25 million was established for the Pyramid Lake fishery.
- [7] **Interstate Water Apportionment Settlement** – Facilitate an interstate allocation of the waters of the Truckee River, Carson River, and Lake Tahoe between the states of California and Nevada.

Also see *Newlands Project [Nevada]*, *Truckee River Agreement [Nevada and California]*, *Truckee River Operating Agreement (TROA) [Nevada and California]*, and *Operating Criteria and Procedures (OCAP) [Nevada]*.

Nekton — (Ecology) (1) Macroscopic organisms swimming actively in water, such as fish. A collective term for all organisms that swim actively in open water, independent of water currents. (2) The consumers in the aquatic environment and consist of large free-swimming organisms that are capable of sustained, directed mobility. Contrast to *Plankton*. Derivative term includes *Nektonic*.

NEPA — See *National Environmental Policy Act (NEPA)*.

Nepheloid Zone — (Oceanography) A cloudy zone that sometimes occurs where there is a strong boundary current at the junction of the sea floor and the continental rise, the turbid water holding in suspension the finest clay and organic particles.

Nephelometer — A device which measures the intensity of light scattered at right angles to its path through a sample. It is used to measure turbidity, and the results are expressed in *Nephelometric Turbidity Units* (NTUs).

Nephelometric — (1) A method of measuring turbidity in a water sample by passing light through the sample and measuring the amount of the light that is deflected. (2) A means of measuring turbidity in a sample by using an instrument called a *Nephelometer*.

Nephelometric Turbidity Unit (NTU) — (1) A unit of measure for the turbidity of water resulting from the use of a *Nephelometer* and based on the amount of light that is reflected off the water. (2) The measurement for reporting turbidity that is based on the use of a standard suspension of Formazin. Turbidity measured in NTU uses nephelometric methods that depend on passing specific light of a specific wavelength through the sample. This unit is not identical to the *Jackson Turbidity Unit* (JTU).

Neritic — (1) Of the shallow regions of a lake or ocean that border the land. The term is also used to identify the biota that inhabit the water along the shore of a lake or ocean. (2) (Oceanography) Of or relating to the pelagic area of the shallow marine environment near shore or over a continental shelf, from low-tide mark down to a depth of about 200 meters, characterized by the abundant biotic activity fostered by photosynthesis and the mineral-rich environment.

Neritic Zone — The relatively shallow water zone that extends from the high tide mark to the edge of the *Continental Shelf*. May also refer to such shallow water regions of lakes.

Net Balance — The change in the mass of a glacier from the time of minimum mass in one year to the time of minimum mass in the next year. Also referred to as *Net Budget*.

Net Consumptive Use — The *Consumptive Use* decreased by the estimated contribution by rainfall toward the production of irrigated crops. Net consumptive use is sometimes called the *Crop Irrigation Requirement*.

Net Depletion — The total water consumed by irrigation, or another use in an area, which is equal to the water withdrawn minus the return flow.

Net Duty of Water — The amount of water delivered to the land to produce a crop, measured at the point of delivery to the field. Also see *Gross Duty of Water*.

Net Economic Benefits — Economic benefits minus economic costs.

Net Precipitation — (1) The amount of precipitation reaching the ground under a vegetative cover, thus, gross precipitation minus interception loss, corrected for stemflow. (2) (Water Quality) The potential for *Leachate* generation from a waste disposal site. It is computed for a specific location by subtracting the annual evaporation from lakes in the region from the normal annual rainfall.

Net (Storm) Rain — The portion of rainfall during a storm which reaches a stream as direct surface flow.

Net Reservoir Evaporation — The difference between the total evaporation from the reservoir water surface and the *Evapotranspiration* from the reservoir area under pre-reservoir conditions, with identical precipitation considered for both conditions.

Net Wastewater Contribution — (Wastewater Treatment) In a wastewater collection system, the net wastewater contribution consists of the liquid wastes and liquid carried wastes transported by the pipelines or received by the pipelines. This value would be the only wastewater found in a collection system if all sources of infiltration, inflow and *Exfiltration* were eliminated.

Net Wastewater Flow — (Wastewater Treatment) The actual wastewater flow from a collection system that reaches a wastewater treatment plant. The net wastewater flow includes the net wastewater contribution, infiltration and inflow and does not include losses through *Exfiltration*.

Net Water Demand — The amount of water needed in an irrigation or water service area to meet all requirements. It is the sum of *Evapotranspiration of Applied Water (ETAW)* in an area, the *Irrecoverable Losses* from the distribution system, and the outflow leaving the irrigation area. It excludes, however, the water reused in the area. Sometimes used interchangeably with *Net Water Use*.

Net Water Use — Refers to water withdrawals plus or minus water transfers. In most areas, the net water use and water withdrawals are equal. However, in areas involved in water transfers (imports and exports), the net water use represents the actual amount of water used regardless of the amount of water actually withdrawn. Sometimes used interchangeably with *Net Water Demand*.

Net Water Yield — The available water runoff at a given location, both surface and subsurface, after the upstream uses by man's activities, use by *Phreatophytes*, and evaporation from upstream free water surfaces.

NETA — See *National Environmental Training Association*.

Neurotoxicity — Exerting a destructive or poisonous effect on nerve tissue.

Neuston — (1) The collection of minute or microscopic organisms that inhabit the surface layer of a body of water. (2) Organisms resting or swimming on the surface of still bodies of water.

Neutral Soil — A soil in which the surface layer, at least to normal plow depth, is neither acid nor alkaline in reaction, approximately 7.0 pH.

Neutral Stress — In a saturated soil, that portion of the total normal stress resulting from the presence of interstitial water. Also referred to as *Pore Pressure* or *Pore-Water Pressure*.

Neutralization — (Chemistry) (1) Decreasing the acidity or alkalinity of a substance by adding alkaline or acidic materials, respectively. (2) A reaction between an acid and a base that yields a salt and water. (3) The equalization of hydrogen and hydroxyl ion concentrations such that the resulting solution is neither acidic nor basic; also, decreasing the acidity or alkalinity of a substance by adding alkaline or acidic materials, respectively. (4) Addition of an acid or alkali (base) to a liquid to cause the pH of the liquid to move toward a neutral pH of 7.0.

Neutrons — An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every

atom heavier than hydrogen. A free neutron is unstable and decays with a half-life of about 13 minutes into an electron, proton, and neutrino. Neutrons sustain the fission reaction in a nuclear reactor.

Nevada Natural Heritage Site [Nevada] — Areas of land or water which either: (1) retain to some degree, or have re-established, a natural character (although it need not be completely undisturbed); or (2) have unusual flora, fauna, geological, scenic, or similar features or scientific, educational or recreational interest.

Nevada Project WET [Nevada] — See *Water Education for Teachers (Project WET) [Nevada]*.

Névé — (1) The upper part of a glacier where the snow turns into ice. (2) A snow field at the head of a glacier. Also, the granular snow typically found in such a field.

New Construction — (FEMA) As used in reference to the *National Flood Insurance Program (NFIP)*, any structures on which construction or substantial improvement was started on or after the effective date of a community's *Floodplain Management Regulations*.

New Source — (Wastewater Treatment) Any building, structure, facility or installation from which there is or may be a discharge of pollutants. Construction of the facility must have begun after publication of the applicable *Pretreatment Standards*. The building, structure, facility or installation must also be constructed at a site at which no other source is located; or, must totally replace the existing process or production equipment producing the discharge at the site; or, must be substantially independent of an existing source of discharge at the same site.

New Source Performance Standards (NSPS) [EPA] — Uniform national *U.S. Environmental Protection Agency (EPA)* air emission and water effluent standards which limit the amount of pollution allowed from new sources or from modified existing sources.

Newland Lake — See *Consequent Lake*.

Newlands (Irrigation) Project [Nevada] — One of the first Department of the Interior, *U.S. Bureau of Reclamation (USBR)* (U.S. Reclamation Service at that time) irrigation projects completed in the United States. The project was authorized originally as the *Truckee-Carson Irrigation Project* on March 14, 1903 by the Secretary of the Interior and was renamed the Newlands Project in 1919 in honor of Nevada Senator Francis G. Newlands, who originally sponsored the 1902 Reclamation Act. Derby Dam, located on the lower Truckee River, was completed in June 1905 to divert waters from the Truckee River Basin to the Carson River. In August 1906 the Truckee Canal was completed between the Truckee and Carson rivers. Waters began flowing through this canal in 1906 while 1907 proved to be the first full year of irrigation. Lahontan Reservoir was completed in 1915 on the Carson River to receive Truckee River waters through the Truckee Canal and provided a more stable supply of water for irrigation needs to a defined service area in the Town of Fernley and the lower Carson River Basin near the City of Fallon, Churchill County, in western Nevada. The project originally (1902) called for the possible irrigation of up to 450,000 acres; however, this figure was continually reduced, finally to approximately 73,000 acres when it was found, after much legal controversy, that the full use of the waters of Lake Tahoe would not be available. Soon after the project was authorized, this figure of irrigable acreage was reduced to 210,000 acres in 1904, to 172,000 acres in 1910, and to 97,400 acres in 1925, of which 73,301 acres were determined to be irrigable in 1926. The project's service area currently consists of approximately 73,800 acres of land that are entitled to receive irrigation water, of which only approximately 58,000–60,000 acres are actually irrigated. Water for these lands is supplied from the Truckee and Carson rivers. Water from the Truckee River is diverted to the Carson River Basin at Derby Dam via the 32.5-mile long Truckee Canal. Since its completion, the Newlands Project has been embroiled in controversy resulting from intense competition for the limited water from these two rivers. Controversy has centered on the actual number of acres with legal water rights, the classification of irrigation lands as *Bench Land* or *Bottom Land* (which determines the applicable water duty — 4.5 AF/year or 3.5 AF/year, respectively), the maximum allowable water duty, the efficiency of project operations, and the volume of water diverted from the Truckee River's terminus, Pyramid Lake. In 1967, *Operating Criteria and Procedures (OCAP)* were first instituted in order to maximize the use of Carson River flows to satisfy project requirements and to minimize water diversions from the Truckee River at Derby Dam. Even so, controversy continued and in 1973, the Federal District Court in Washington, D.C. ordered the implementation of a new OCAP for this project. Amid continued controversy, in 1985 the Bureau of Reclamation published an *Environmental Assessment (EA)* which examined an alternative OCAP. Based on comments to this 1985 EA, the Bureau of Reclamation made the decision to initiate an *Environmental Impact Statement (EIS)*. A final OCAP was approved in 1988. *Public Law 101-618*, enacted on November 16, 1990, (also referred to as the *Negotiated Settlement*), requires the current OCAP to remain in effect at least through December 31, 1997, and is intended to allow all principal parties to develop a new *Truckee River Operating Agreement (TROA)*. A major issue in the current litigation has been to secure an adequate water supply (both as to quantity and quality) to preserve Pyramid Lake and protect its environmentally sensitive fish species, the endangered cui-ui (*Chasmistes cujus*) and the threatened Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*).

Newlands (Irrigation) Project Efficiency [Nevada] — The ratio of irrigation delivery demand to Lahontan Reservoir releases, excluding spills.

Newlands Water Protective Association (NWPAA) [Nevada] — A water right owners association formed to protect the Newlands Irrigation Project water rights and supply.

New Source Performance Standards (NSPS) [EPA] — Effluent limitations set by the *U.S. Environmental Protection Agency (EPA)* for new *Point Sources (PS)* of water pollution. The standards are applied to industry categories (*Standard Industrial Classification [SIC] Codes*), such as petroleum refineries and phosphate manufacturers.

Niche Glacier — A small *Glacier* that occupies a funnel-shaped or irregular hollow in the slope of a mountain.

Nick Point (Bedscarp) — (1) The point at which a stream is actively eroding the streambed to a new base level. (2) An abrupt change in grade in the bottom of a stream channel that moves progressively upstream; the change in grade forms a waterfall. Also, the location where a streambed is actively eroding downward to a new base level.

Nieve Penitente — A jagged pinnacle or spike of snow or firn produced by differential melting and evaporation as a result of exposure to intense solar radiation. Also referred to as *Penitent*, *Snow Penitente*, or *Sun Spike*.

Nilas — A thin, elastic, gray-colored crust of ice formed on a calm sea.

Nimbostratus Clouds — Rain clouds in layers that are generally spread across the sky; a low, gray, often dark cloud that precipitates rain, snow, or sleet. Also see *Cloud*.

Nimbus Clouds — A rain-producing cloud; storm clouds that are usually dark in color. Also see *Cloud*.

Ninetieth Percentile — See *90th Percentile* (first entry under the letter “N”).

Nip — (1) A point on the lobe of a meander where the crowding of the stream current toward the lobe erodes the bank. (2) (Geology) A small, low cliff produced at the high-water mark by wavelets.

NIPDWR — National Interim Primary Drinking Water Regulations.

Nitrates — (1) A dissolved form of nitrogen found in fertilizers and sewage by-products which may leach into groundwater and other water sources. Nitrates may also occur naturally in some waters. Over time, nitrates can accumulate in aquifers and contaminate groundwater. (2) A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and which can have harmful effects on humans and animals. Nitrates in water can cause severe illness in infants and domestic animals. A plant nutrient and inorganic fertilizer, nitrate is found in septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills, and garbage dumps. (3) Nitrates represent a class of chemical compounds having the formula NO_3^- . Nitrate salts are used as fertilizers to supply a nitrogen source for plant growth. Nitrate additions to surface waters can lead to excessive growth of aquatic plants. The presence of nitrates in groundwater occurs from the conversion of nitrogenous matter into nitrates by bacteria and represents the process whereby ammonia in wastewater, for example effluent discharges from septic tank systems, is oxidized to nitrite and then to nitrate by bacterial or chemical reactions. High groundwater nitrate levels can cause methemoglobinemia in infants.

Nitrification — (1) The biochemical transformation of ammonium nitrogen to nitrate nitrogen. (2) The conversion of nitrogenous matter into *Nitrates* by bacteria; the process whereby ammonia in wastewater is oxidized to nitrite and then to nitrate by bacterial or chemical reactions.

Nitrification Inhibitor — A chemical that slows down the conversion of ammonium to nitrate nitrogen.

Nitrification Stage — (Wastewater Treatment) A stage of decomposition that occurs in biological treatment processes when *Aerobic* bacteria, using dissolved oxygen, change nitrogen compounds (ammonia and organic nitrogen) into oxidized nitrogen (usually nitrate). The second stage *Biochemical Oxygen Demand (BOD)* is sometimes referred to as the “nitrification stage” (first stage BOD is called the “carbonaceous stage”).

Nitrifying Bacteria — Bacteria that change the ammonia and organic nitrogen in wastewater into oxidized nitrogen (usually nitrate).

Nitrilotriacetic Acid (NTA) — A compound now replacing *Phosphates* in detergents.

Nitrogen — (1) (General) Chemical symbol N, the gaseous, essential element for plant growth, comprising 78 percent of the atmosphere, which is quite inert and unavailable to most plants in its natural form. (2) One of the three primary nutrients in a complete fertilizer and the first one listed in the formulation on a fertilizer label: 10-8-6 (nitrogen, phosphorus, potassium). (3) (Water Quality) A nutrient present in ammonia, nitrate or nitrite or elemental form in water due possibly to *Nonpoint Source (NPS)* pollution or improperly operating wastewater treatment plants.

Nitrogen Cycle — (Ecology) (1) The circulation of *Nitrogen* in nature, consisting of a cycle of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, and deposited in the soil, where it is assimilated and metabolized by bacteria and plants, eventually returning to the atmosphere by bacterial decomposition of organic matter. (2) The continuous process by which nitrogen circulates among the air, soil, water, plants, and animals of the earth. Specifically, nitrogen in the atmosphere is converted by bacteria into substances that green plants can absorb from the soil. Animals eat these plants (or eat other animals that feed on the plants). The animals and plants die and decay and the nitrogenous substances in the decomposed organic matter return to the atmosphere and the soil. (3) Also, a model illustrating conversion of nitrogen from one form to another through a combination of biological, geological, and chemical processes. The process is continuous, with atmospheric nitrogen, N_2 , being converted to forms usable by biota and then ultimately returning to the atmosphere as N_2 . (4) The continuous sequence of changes by which atmospheric nitrogen and nitrogenous compounds in the soil are converted, as by nitrification and nitrogen fixation, into substances that can be utilized by green plants, the substances returning to their previous state after the plants decay, and by denitrification into substances that cannot be utilized by the plants.

Nitrogen Fixation — (1) The biological or chemical process by which elemental nitrogen, from the air, is converted to organic or available nitrogen. (2) The conversion of elemental nitrogen in the atmosphere (N_2) to a reduced form (e.g., ammonia and amino groups of amino acids) that can be used as a nitrogen source by organisms. The process is important since all organisms require a source of nitrogen for nutrition, and N_2 cannot be used by the great majority of the biota to satisfy that need. Biological nitrogen fixation is carried out by a variety of organisms; however, those responsible for most of the fixation are certain species of bluegreen algae, the soil bacterium *Azotobacter*, and the symbiotic association of plants of the legume variety and the bacterium *Rhizobium*.

Nitrogen-Fixing Plants — Plants that can assimilate and fix the free nitrogen of the atmosphere with the aid of bacteria living in the root nodules. Legumes with the associated rhizobium bacteria in the root nodules are the most important nitrogen-fixing plants.

Nitrogen Narcosis — A state of euphoria and exhilaration that occurs when nitrogen in normal air enters the bloodstream at approximately seven times atmospheric pressure (as in deep-water diving). Also called *Rapture of the Deep*.

Nitrogen Oxides (NO_x) — (1) Any inorganic compound containing both nitrogen and oxygen. These compounds act as *Precursors* to other pollutants such as nitrate and ozone. NO_x includes nitric oxide (NO), nitrogen dioxide (NO_2), and others. NO_x are formed by natural processes such as lightning, forest fires, and microbial processes. Anthropogenic sources include agricultural

- fertilizers and combustion engines. It is estimated that man-made sources currently equal natural sources. (2) The result of photochemical reactions of nitric oxide in ambient air; major component of photochemical smog. Product of combustion from transportation and stationary sources and a major contributor to the formation of ozone in the troposphere and to *Acid Deposition*.
- Nitrogenous** — A term used to describe chemical compounds (usually organic) containing nitrogen in combined forms. Proteins and nitrates are nitrogenous compounds.
- Nitrogenous BOD** — (Water Quality) The amount of molecular oxygen required for the microbial oxidation of ammonia and nitrite contaminants in a specified volume of wastewater. This type of oxygen demand can complicate the interpretation of data obtained from the determination of the *Biochemical Oxygen Demand (BOD)* of treated sewage, although a chemical can be added to the BOD test to prevent ammonia oxidations. Ammonia and nitrite are oxidized by *Chemoautotrophic Bacteria*.
- Nitrogenous Waste** — (Water Quality) Wastewater that contains inorganic forms of nitrogen, including ammonia and nitrite.
- Nitrogen Supersaturation** — A condition of water in which the concentration of dissolved nitrogen exceeds the saturation level of water. Excess nitrogen can harm the circulatory systems of fish.
- Nival** — (Ecology) (1) Relating to or living in a snowy environment. (2) Of, relating to, or growing in or under snow.
- Nival Gradient** — The angle made by a *Nival Surface* with the horizontal.
- Nival Plane** — See *Nival Surface*.
- Nival Surface** — The imaginary plane containing all the snowlines of the same geologic time period. Also referred to as *Nival Plane*.
- Nivation** — The erosion of rock or soil beneath a snowbank or snow patch and along its fluctuating margins, due to frost action in conjunction with other processes such as chemical weathering and solifluction. Also referred to as *Snow-Patch Erosion*.
- Nivation Glacier** — A small, newly formed glacier representing the initial stage of glacier formation. Also referred to as *Snowbank Glacier*.
- Nivation Hollow** — A small, shallow recess or depression produced by *Nivation* and occupied intermittently by a snow patch or snowbank. Also referred to as *Snow Niche*.
- Niveal** — Of or relating to features and effects resulting from the action of snow and ice.
- Niveoglacial** — Of, related to, or caused by the combined action of snow and ice.
- Niveolian** — Of, related to, or caused by the simultaneous accumulation and intermixing of snow and airborne sand at the side of a gentle slope.
- Niverous** — Resembling snow; snowy.
- No Action Alternative** — Projected baseline condition, or anticipated future condition without a given action being taken. The expected future condition if no action is taken – not necessarily the same as the present condition. The effects of action alternatives are measured against this baseline condition.
- No Further Remedial Action Planned (NFRAP) [EPA]** — An archival database contains information on sites which have been removed from the inventory of Superfund sites. Archive status indicates that to the best of the EPA's knowledge, Superfund has completed its assessment of a site and has determined that no further steps will be taken to list that site on the *National Priorities List (NPL)*.
- No Till Farming** — Planting crops without prior seedbed preparation, into an existing cover crop, sod, or crop residues, and eliminating subsequent tillage operations.
- NO_x** — Oxides of nitrogen, specifically NO (nitric oxide), NO₂ (nitrogen dioxide or nitrogen peroxide), and NO₃, nitrate.
- NOAA** — See *National Oceanic and Atmospheric Administration (NOAA)*.
- NOAEL** — No-observed-adverse-effect level; the highest dose in an experiment which did not produce an observable adverse effect.
- Noble Metal** — A chemically inactive metal such as gold; does not corrode (oxidize) easily.
- NOEL** — No-observed-effect level; dose level at which no effects are noted.
- Noggin** — A unit of liquid measure equal to one quarter of a pint.
- NOM** — See *Natural Organic Matter*.
- Nominal** — Used to describe standard sizes for pipe from 1/2 inch to 12 inches (3.2 mm to 305 mm). The nominal size is specified on the basis of the inside diameter. Depending on the wall thickness, the inside diameter may be less than or greater than the number indicated.
- Nominal Diameter** — An approximate measurement of the diameter of a pipe. Although the nominal diameter is used to describe the size or diameter of a pipe, it is usually not the exact inside diameter of the pipe.
- Non-Aqueous-Phase Liquids (NAPLs)** — (Water Quality) (1) Organic chemicals (contaminants) that are *immiscible* with water. Also, NAPLs are frequently toxic to many microorganisms used in *Bioremediation*. Such organic contaminants may be lighter than water (LNAPLs) or denser than water (DNAPLs). DNAPLs have proven to be one of the most difficult remediation problems to surmount and frequently constitute the more common pollutants found in water. (2) Hydrocarbons that exist as a separate immiscible phase when in contact with water or air. Differences in the physical and chemical properties of water and NAPLs result in the formation of a physical interface between the two fluids which prevent the two fluids from mixing. NAPLs are typically classified as either light non-aqueous phase liquids (LNAPLs), which have densities less than that of water, or dense non-aqueous phase liquids (DNAPLs), which have densities greater than that of water. (Note, some professionals have referred to NAPLs with densities close to that of water as neutrally buoyant non-aqueous phase liquids (NNAPLs).)
- Nonartesian Water** — Groundwater that is not confined under pressure beneath relatively impermeable rock; it thus is not capable of rising if released, as artesian water would be.
- Nonbiodegradable** — Substances that cannot readily be broken down by bacteria to simpler forms.
- Noncohesive Soil** — Soil particles that have no natural resistance to being pulled apart at their point of contact, for example, silt, sand, and gravel.

Non-Commercial Purposes — The term, “non-commercial purposes,” means tree plantings specifically for conservation purposes, excluding trees planted for ornamental or commercial purposes.

Non-Community Water System (NCWS) — (1) A public water system that is not a community water system, e.g., the water supply at a camp site or national park. (2) A public water system that is not a community water system. There are two types of NCWSs: transient and non-transient.

Noncompatible Pollutants — (Wastewater Treatment) Those pollutants which are normally not removed by the *Publicly Owned Treatment Works (POTW)* treatment system. These pollutants may be a toxic waste and may pass through the POTW untreated or interfere with the treatment system. Examples of noncompatible pollutants include heavy metals such as copper, nickel, lead, and zinc; organics such as methylene chloride, 1,1,1 trichloroethylene, methyl ethyl ketone, acetone, and gasoline; or sludges containing toxic organics or metals.

Non-Consumptive Water Use — Nonconsumptive water use includes water withdrawn for use that is not consumed, for example, water withdrawn for purposes such as hydropower generation. This also includes uses such as boating or fishing where the water is still available for other uses at the same site. The terms *Consumptive Use* and *Nonconsumptive Use* are traditionally associated with water rights and water use studies, but they are not completely definitive. No typical consumptive use is 100 percent efficient; there is always some return flow associated with such use either in the form of a return to surface flows or as a groundwater recharge. Nor are typically nonconsumptive uses of water entirely nonconsumptive. There are evaporation losses, for instance, associated with maintaining a reservoir at a specified elevation to support fish, recreation, or hydro-power, and there are conveyance losses associated with maintaining a minimum streamflow in a river, canal, or ditch.

Non-Contact Cooling Water — Water used for cooling which does not come into direct contact with any raw material, product, byproduct, or waste.

Non-Contact Recreation — Recreational pursuits not involving a significant risk of water ingestion, including fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity.

Non-Contributing Area — An area within a drainage basin having no direct connection with the basin’s principal drainage system.

Non-Conventional Pollutant — (1) Any pollutant which is not a statutorily listed or which is poorly understood by the scientific community. (2) Under the *Clean Water Act (CWA)*, a water pollutant not listed as conventional pollutants, toxic pollutants, or thermal discharges. These include chloride, iron, ammonia, color, and total phenols.

Non-Degradation Policy — An environmental policy which disallows any lowering of naturally occurring quality regardless of preestablished health standards.

Nondestructive Testing (NDT) — In geophysical surveying, methods used to detect subsurface water, subsurface containers, or the areal extent of groundwater contamination without soil borings. The testing involves the use of acoustic soundings, infrared radiation, x-rays, magnetic field perturbations, and electrical resistivity, among other methods.

Nondischarging Treatment Plant — A treatment plant that does not discharge treated wastewater into any stream or river. Most are pond systems that dispose of the total flow they receive by means of evaporation or percolation to groundwater, or facilities that dispose of their effluent by recycling or reuse, for example spray irrigation or groundwater discharge.

Non-Filtrable Residue — The total quantity of substances in a sample which can be removed by filtration through a 0.45 μm membrane filter. Reported in milligrams per liter (mg/l), and sometimes referred to as *Suspended Solids*.

Nonfull-Cost Entitlement [USBR] — Maximum acreage, whether held directly or indirectly, that a landholder may irrigate with Reclamation irrigation water at less than the *Full-Cost Rate*.

Nongraded — An engineering term pertaining to a soil or an unconsolidated sediment consisting of particles of essentially the same size.

Nonhazardous Oil Field Waste (NOW) — Wastes generated by drilling of and production from oil and gas wells that are not classified by the *U.S. Environmental Protection Agency (EPA)* regulations as hazardous wastes. Typical NOW’s include drilling muds, cuttings, drilling fluids, and *Produced Water*.

Nonintegrated Facility — (Wastewater Treatment) Plants that produce wastewaters from different pretreatment categorical processes but do not combine the wastestreams prior to pretreatment or discharge to sewers.

Non-Irrigated Cropland — Those non-irrigated cultivated lands that are used for the production of grain crops (harvested and/or grazed), orchard, and field crops.

Non-Interruptible — Water provided by a water project or utility district that is not subject to any interruption.

Nonpersistent Emergents — *Emergent Hydrophytes* whose leaves and stems break down at the end of the growing season so that most above-ground portions of the plants are easily transported by currents, waves, or ice. The breakdown may result from normal decay or the physical force of strong waves or ice. At certain seasons of the year there are no visible traces of the plants above the surface of the water; e.g., wild rice (*Zizania aquatica*), arrow arum (*Peltandra virginica*).

Nonpersistent Pollutant — A substance that can cause damage to organisms when added in excessive amounts to the environment but is decomposed or degraded by natural biological communities and removed from the environment relatively quickly. Contrast with *Persistent Pollutant*.

Non-Point Source (NPS) Pollution — (1) Pollution discharged over a wide land area, not from one specific location. (2) Pollution sources which are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by storm water runoff. The commonly used categories for non-point sources are: agriculture return flows, forestry, urban, mining, construction, dams and channels, land disposal, and saltwater intrusion. (3) Water pollution caused by diffuse sources with no discernible distinct point of source, often referred to as runoff or polluted runoff from agriculture, urban areas, mining, construction sites and other sites. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land use activities, which are carried to lakes and streams by surface runoff. Technically, non-point source pollution, also referred to as *Non-Point Water Pollution* or *Diffuse*

Source Pollution means any water contamination that does not originate from a “point source,” which is designated in the *Clean Water Act (CWA)* as pollution that can be clearly identified as a discharge from a pipe, ditch, or other well-defined source. Non-point source pollution, by contrast, is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants such as nutrients and pesticides. Some of the polluted runoff infiltrates into the soil to contaminate (and recharge) the groundwater below. The rest of the runoff deposits the soil and pollutants in rivers, lakes, wetlands, and coastal waters. Originating from numerous small sources, non-point source pollution is widespread, dispersed, and hard to pinpoint. Compared with point source pollution, it is diffuse and difficult to control or prevent. It has been estimated that non-point source pollution accounts for more than one-half of the water pollution in the United States today.

Non-Point Sources — Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Common non-point sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets. See *Non-Point Source (NPS) Pollution*.

Non-Point Water Pollution — See *Non-Point Source (NPS) Pollution*.

Nonporous — Something which does not allow water to pass through it. More specifically, a material with no void spaces.

Non-Potable — (1) Water that may contain objectionable pollution, contamination, minerals, or infective agents and is considered unsafe and/or unpalatable for drinking. (2) Used to describe water that is not suitable for drinking because it contains pollutants, contaminants, minerals, or infective agents.

Nonreimbursable Costs — Water project costs allocated to general statewide or national beneficial purposes and funded from general fund revenues, rather than by water users.

Nonrenewable Resource — (Ecology) (1) A natural resource that does not naturally replenish itself within the limits of human time. (2) A substance such as oil, gas, coal, copper, gold, etc., which, once used, cannot be replaced, at least not in this geological age. (3) A substance that is formed at a rate far slower than its rate of consumption and is therefore not able to be replenished within human time scales; e.g., fossil fuels. Also referred to as a *Finite Resource*. Also see *Natural Resources* and *Renewable Resources*.

Nonstructural Measures — Measures for managing, utilizing, or controlling water and related lands without structural development to achieve the desired objective. Such measures include best management practices, flood plain zoning, flood warning systems, education and legal restraints, and preservation, as well as the more common land management measures.

Nonstructural Flood Control Measures — Measures such as zoning ordinances and codes, flood forecasting, flood proofing, evacuation and channel clearing, flood fight activities, and upstream land treatment or management to control flood damages without physically restraining flood waters. Also see *Nonstructural Floodplain Management Measures*.

Nonstructural Floodplain Management Measures — Those measures employed to modify the exposure of buildings to floods, e.g., floodproofing, land use planning, warning schemes, and insurance, as opposed to structural measures such as dams, levees, and channel modifications.

Non-Threshold Pollutant — A substance or condition harmful to a particular organism at any level or concentration.

Non-Tidal Wetland — A non-tidal wetland is a *Wetland* (i.e., a water of the United States) that is not subject to the ebb and flow of tidal waters. The official United States definition of a wetland can be found at 33 Code of Federal Regulations (CFR) 328.3(b). Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., the spring high tide line). See *Wetlands [United States, 33 CFR 328.3(b)]*.

Non-Transient, Non-Community Water System (NTNCWS) — (1) A public water system that regularly serves at least 25 of the same non-resident persons per day for more than six months per year. (2) A public water system that is not a community water system and that regularly serves at least 25 of the same people over six months per year. Common types of such water systems are those serving schools, daycare centers, factories, restaurants, nursing homes, and hospitals.

Nonuniform Flow — (Hydraulics) Flow in which the mean velocity or cross-sectional area vary at successive channel cross-sections. If the velocity at a given cross-section is constant with time, it is referred to as *Steady Nonuniform Flow*. If the velocity changes with time at each cross-section, it is known as *Unsteady Nonuniform Flow*.

Non-Volatile Solids (NVS) — The quantity of solids in water, wastewater or other liquids, not lost by ignition of the dry solids at 600EC. Reported in milligrams per liter (mg/l).

Non-Volatile Suspended Solids (NVSS) — The quantity of solids in a sample which is removed by filtration but not lost by ignition at 600EC. Reported in milligrams per liter (mg/l).

Non-Velocity Coastal Flood Area [FEMA] — Any area that is subject to inundation by tidal waters which has lower velocity or wave components than a *Coastal High Hazard Area*.

Nonwithdrawal Use — Use which does not require diversion. Navigation, recreation, waste disposal and conservation of fish and wildlife are examples of nonwithdrawal uses. Such uses are typically nonconsumptive uses of water. Also referred to as *Instream Use* and *In-Channel Use*.

Noria — A water wheel with buckets attached to its rim, used to raise water from a stream, especially for transfer to an irrigation channel.

Normal (Hydrologic) — A central value (such as an arithmetic average or median) of annual quantities for a 30-year period ending with the first year of a decade, e.g., 1931–1960, 1961–1990.

Normal (Solution) — A normal solution contains one grain equivalent weight of reactant (compound) per liter of solution. The equivalent weight of an acid is that weight which contains one gram atom of ionizable hydrogen or its chemical equivalent. For example, the equivalent weight of sulfuric acid (H_2SO_4 is 49 (98 divided by 2 because there are two replaceable hydrogen ions)). A one N solution of sulfuric acid would consist of 49 grains of H_2SO_4 dissolved in enough water to make one liter of solution.

Normal Annual Precipitation — Average annual precipitation during a base period.

Normal Daily Temperature — The average daily mean temperature for a given date, computed for a specific 30-year period.

Normal Distribution — (Statistics) A fundamental underpinning of statistical and econometric analysis: that if repeated samples are drawn (observed) from a population, that as the sample size grows then the observed values will centralize around a non-random value, termed the expected value. A normal distribution of observations may be pictured as a “bell-shaped” curve, with a central peak and symmetrical “tails” on either side. In a normal distribution, the *(Arithmetic) Mean* (the average value of all observations) is also equal to the *Mode* (the most frequently occurring) and the *Median* (the middle-most with an equal number of observations appearing below and above).

Normal Erosion — (Geology) Erosion that is caused by running water and the weathering processes. Normal erosion is primarily responsible for the present modification of the land surface. Also referred to as *Geologic Erosion*.

Normal Fault — (Geology) A *Fault* in which the hanging wall appears to have moved downward relative to the footwall.

Normal Hydrostatic Pressure — The pressure at a given point in a porous stratum or well, approximately equal to the weight of a column of water which extends from that point to the surface.

Normal Water Level — For a reservoir with a fixed overflow, the lowest crest level of that overflow. For a reservoir whose outflow is controlled wholly or partly by movable gates, siphons or other means, it is the maximum level to which water may rise under normal operating conditions, exclusive of any provision for flood surcharge.

Normal Year — A year during which the precipitation or streamflow approximates the average for a long period of record.

Normalized Demand — The process of adjusting actual water use in a given year to account for unusual events such as dry weather conditions, government interventions for agriculture, rationing programs, or other anomalies.

North American Industry Classification System (NAICS) — A code number system used to identify various types of industries. This code is intended to replace the *Standard Industrial Classification (SIC)* code system used prior to 1997. Use of these code numbers is often mandatory. Some companies have several processes which will cause them to fit into two or more classifications. The importance of industry codes is not only the principal type of business that a firm does, but also it identifies the firm’s water use characteristics and type of wastewater the firm or industry will be delivering to a wastewater treatment plant. The code numbers are published by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. ISBN 0-16-049699-3.

North American Vertical Datum Plane — Elevation datum currently used by the *Federal Emergency Management Agency (FEMA)* for the determination of flood elevations, replacing the *National Geodetic Vertical Datum (NGVD)* which had been used previously.

North American Wetlands Conservation Act [USFWS] — The North American Wetlands Conservation Act (Act) of 1989 provides matching grants to private or public organizations or to individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico. The Act was passed, in part, to support activities under the North American Waterfowl Management Plan (NAWMP), an international agreement that provides a strategy for the long-term protection of wetlands and associated uplands needed by waterfowl and other migratory birds in North America. The Act authorizes up to \$50 million in congressional appropriations per year through fiscal year 2003. Additional funding comes from moneys received from fines, penalties, and forfeitures under the Migratory Bird Treaty Act of 1918, and from interest accrued on the fund established under the Federal Aid in Wildlife Restoration Act of 1937. Amendments to the Federal Aid in Sport Fish Restoration Act of 1950 also directed a portion of the moneys collected from federal fuel excise taxes on small gasoline engines be allocated for use under the Act for coastal ecosystem projects. Over the past 4 years (1997-2001), an average of about \$44 million has been available annually from all sources. The Act is intended to do several things:

- [1] Encourages partnerships to conserve North American wetland ecosystems for waterfowl, other migratory birds, fish, and wildlife;
- [2] Encourages the formation of public-private partnerships to develop and implement wetland conservation projects consistent with the NAWMP, a blueprint for continental waterfowl and wetlands conservation, and other North American migratory bird conservation agreements;
- [3] Creates the North American Wetlands Conservation Fund to help support projects through grants;
- [4] Establishes the North American Wetlands Conservation Council to review and recommend grant proposals to the Migratory Bird Conservation Commission for funding;
- [5] Lists proposed evaluation factors to be considered by the Council; and
- [6] Specifically references goals of the NAWMP and provides a mechanism to support NAWMP’s objectives and those of other migratory bird recovery programs.

The function of the North American Wetlands Conservation Council is to review and recommend project proposals to the Migratory Bird Conservation Commission, which has the authority to approve funding for projects. The Council is comprised of nine members to include:

- [1] Director of the U.S. Fish and Wildlife Service (USFWS);
- [2] Executive Secretary of the National Fish and Wildlife Foundation (NFWF);
- [3] Four state representatives (one from each flyway); and
- [4] Three non-governmental organization representatives (each from a different non-governmental organization that is an active partner in wetlands conservation and are appointed by the Secretary of the Interior).

From 1991 through 2001, more than 1,700 partners have been involved in 857 Act-supported projects. Projects must meet certain biological criteria, and grant requests are limited to \$1 million. Partners must minimally match the grant request at a 1-to-1 ratio. A total of \$263.1 million in the United States, \$164 million in Canada, and \$14.1 million in Mexico in grants has been invested

in wetlands conservation under the Act; total partner contributions have amounted to \$929.3 million in the United States, \$250.5 million in Canada, and \$21.8 million in Mexico. Approximately 2.8 million acres in the United States, 5.2 million in Canada and 444 thousand in Mexico have been affected.

Notch — The opening in a dam or spillway for the passage of water.

Nourishment — (1) See *Accumulation*. (2) Geology) The replenishment of a beach by either natural or artificial means.

Noxious Plant — A harmful plant species. Also see *Noxious Weed*.

Noxious Weed — A plant species that possesses one or more of the following attributes: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host of serious insect or disease and being native or new to or not common to the United States or parts thereof. Also referred to as *Noxious Plant*.

NPDES — See *National Pollutant Discharge Elimination System*.

NPDES Permit — (1) A permit issued under the *National Pollutant Discharge Elimination System (NPDES)* for companies discharging pollutants directly into the waters of the United States. (2) The NPDES permit is the regulatory agency document issued by either a federal or state agency which is designed to control all discharges of pollutants from point sources and storm water runoff into U.S. waterways. NPDES permits regulate discharges into navigable waters from all point sources of pollution, including industries, municipal wastewater treatment plants, sanitary landfills, large agricultural feedlots and return irrigation flows.

NPDWR — See *National Primary Drinking Water Regulations*.

NPL — See *National Priorities List*; a list of Superfund sites chosen for immediate attention.

NPS Pollution — See *Non-Point Source Pollution*.

NSDWR — See *National Secondary Drinking Water Regulations*.

NSF — National Sanitation Foundation.

NTNC — Non-Transient Non-Community (water system).

NTNCWS — See *Non-Transient Non-Community Water System*.

NTP — National Toxicology Program.

NTU — A unit of measure for the turbidity water based on the amount of light that is reflected off the water. See *Nephelometric Turbidity Unit*. Also see *Turbidity Units (TU)*.

NTWS — Non-Transient Water System.

Nuclear Power Plant — Any device that converts nuclear energy into some form of useful power such as mechanical or electrical power. In a nuclear electric power plant, heat produced by a reactor is generally used to make steam to drive a turbine that in turn drives an electric generator.

Nuclear Reactor — A device in which a fission chain reaction can be initiated, maintained, and controlled. Its essential component is a core with fissionable fuel. It usually has a moderator, a reflector, shielding, coolant, and control mechanisms. Sometimes called an atomic “furnace,” it is the basic machine of nuclear energy.

Nuclear Twin-Probe Gauge — See *Profiling Snow Gauge*.

Nucleating Agent — In cloud physics, any substance that serves to accelerate the *Nucleation* of cloud particles. Nucleating agents may themselves be nuclei (silver iodide, salt, sulfur dioxide, dust) or they may enhance the nucleation environment (dry ice, propane spray).

Nucleation — Any process by which the phase change of a substance to a more condensed state (condensation, sublimation, freezing) is initiated at certain loci, nuclei, within the less condensed state.

Nucleus — A small particle around which molecules of water may condense or freeze.

Nuclide — A general term applicable to all atomic forms of the elements. The term is often erroneously used as a synonym for isotope which properly has a more limited definition. Whereas isotopes are the various forms of a single element (hence they are a family of nuclides) and all have the same atomic number and number of protons, nuclides comprise all the isotopic forms of all the elements. Nuclides are distinguished by their atomic number, atomic mass, and energy state.

Nuisance Flooding — Flooding which causes public inconvenience, but little or no property damage. Also referred to as *Minor Flooding*. Also see *Major Flooding* and *Moderate Flooding*.

Nutrient — (1) An element or compound essential to life, including carbon, oxygen, nitrogen, phosphorus, and many others. (2) Animal, vegetable, or mineral substance which sustains individual organisms and ecosystems. (3) That portion of any element or compound in the soil that can be readily absorbed and assimilated to nourish growing plants, e.g., nitrogen, phosphorus, potassium, iron. (4) Any substance that is assimilated (taken in) by organisms and promotes growth. Nitrogen and phosphorus are nutrients which promote the growth of algae. There are other essential and trace elements which are also considered nutrients. (5) (Wastewater Treatment) Substances which are required to support living plants and organisms. Major nutrients are carbon, hydrogen, oxygen, sulfur, nitrogen and phosphorus. Nitrogen and phosphorus are difficult to remove from wastewater by conventional treatment processes because they are water soluble and tend to recycle. Also see *Nutrient Cycle*.

Nutrient Cycle — (1) The transformation or change of a nutrient from one form to another until the nutrient has returned to the original form, thus completing the cycle. The cycle may take place under either *Aerobic* or *Anaerobic* conditions. (2) The cyclic conversions of nutrients from one form to another within the biological communities. A simple example of such a cycle would be the production and release of molecular oxygen (O₂) from water (H₂O) during photosynthesis by plants and the subsequent reduction of atmospheric oxygen to water by the respiratory metabolism of other biota. The cycle of nitrogen is much more complex, with the nitrogen atom undergoing several changes in oxidation state (N₂, NO₃⁻, R — NH₂, and NH₄⁺, among others) during the cycling of this element through the biological community, and into the air, water, or soil, and back.

Nutrient Pollution — Contamination of water resources by excessive inputs of nutrients. In surface waters, excess algal production is a major concern. Although natural sources of nutrients exist, major sources are typically *Anthropogenic* (caused by man's

activities) and include point sources such as municipal sewage-treatment plants and industrial outflows, and non-point sources such as commercial fertilizers, animal waste, and combustion emissions. Most of the recent legislation to curb nutrient pollution has been targeted towards such goals as updating sewage-treatment plants to reduce phosphorus and nitrogen in effluents, bans on phosphorous in laundry detergents, and controlling agriculture operations to control the flow of nitrogen and phosphorous from fertilizers entering natural waters.

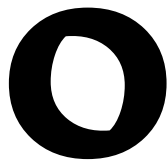
Nutrient Sink — See *Natural Sink*.

Nutrient Spiraling — Recycling of nutrients between the water column and stream bed.

NWPA — See *Newlands Water Protective Association (NWPA)*.

NWS — See *National Weather Service (NWS)*.

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Oasis — A fertile or green spot in a desert or wasteland, made so by the presence of water.

Obligate Aerobes — Bacteria that must have atmospheric or dissolved molecular oxygen to live and reproduce.

Obligate Hydrophytes — Species that are found only in *Wetlands*, e.g., cattail (*Typha latifolia*) as opposed to *Ubiquitous Hydrophytes*, species that grow either in wetland or on upland areas – e.g., red maple (*Acer rubrum*).

Observation Well — A well used to monitor changes in water levels of an aquifer and to obtain samples for water quality analyses. Also referred to as a *Monitoring Well*. Also see *Wellhead Protection Program*.

Obsidian Hydration Studies — A method of determining the approximate age of an obsidian artifact by the measurement of the thickness of a microscopically visible “rind” on a flaked edge, resulting from the absorption of water.

Obstructed Stream — A stream whose valley has been blocked by an obstruction such as a landslide, glacial moraine, or lava flow.

Obstruction — Includes, but is not limited to, any dam, wall, wharf, embankment, levee, dike, pile, abutment, protection, excavation, channelization, bridge, conduit, culvert, building, wire, fence, rock, gravel refuse, fill, structure, vegetation or other material in, along, across or projecting into any watercourse which may alter, impede, retard or change the direction and/or velocity of the flow of water, or due to its location, its propensity to snare or collect debris carried by the flow of water, or its likelihood of being carried downstream.

OCAP (Operating Criteria and Procedures) [Nevada] — Operating criteria originally instituted in 1967 for water diversions and irrigation of the *Newlands (Irrigation) Project [Nevada]* in the Carson River Basin and designed to maximize use of Carson River flows to satisfy project requirements and minimize diversions from the Truckee River. Current OCAP requirements for this project were set in 1988 and according to *Public Law 101–618 (the Negotiated Settlement)* are to remain in effect at least through December 31, 1997 at which time a new *Truckee River Operating Agreement (TROA) [Nevada and California]* will be implemented.

Occluded Front — The widespread (cloudiness and precipitation) that results when the faster-moving cold front overtakes the warm front and lifts it aloft, often stalling in the process.

Ocean — Generally, the whole body of salt water which covers nearly three fourths of the surface of the globe. The average depth of the ocean is estimated to be about 13,000 feet (3,960 meters); the greatest reported depth is 34,218 feet (10,430 meters), north of Mindanao in the Western Pacific Ocean. The ocean bottom is a generally level or gently undulating plain, covered with a fine red or gray clay, or, in certain regions, with ooze of organic origin. The water, whose composition is fairly constant, contains on the average 3½ percent of dissolved salts; of this solid portion, common salt forms about 78 percent, magnesium salts 15-16 percent, calcium salts 4 percent, with smaller amounts of various other substances. The density of ocean water is about 1.026 (relative to distilled water, or pure H₂O). The oceans are divided into the Atlantic, Pacific, Indian, Arctic, and Antarctic Oceans. See *Oceans (World)*.

Ocean Basin — (Geology) A depression on the surface of the *Lithosphere* occupied by an ocean.

Ocean Currents — (Oceanography) A movement of ocean water that follows a more or less definite pattern, usually moving in a continuous flow but sometimes undergoing marked cyclical as well as seasonal changes. Currents of the world's oceans flow in complex patterns affected by wind, the water's salinity and heat content, bottom topography, and the earth's rotation. Ocean currents influence climate and living conditions for plants and animals across both aquatic and terrestrial environments. The earth's rotation and the change in wind direction with latitude (from the east in the tropics and from the west at mid-latitudes) cause the circulation of the earth's major ocean currents. *Gyres* form in all the oceans when the major ocean currents connect and the resultant flows move in circular patterns – clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. The well-known Gulf Stream in the Atlantic Ocean and its counterpart in the Pacific Ocean, the Kuroshio Current, are strong currents that carry heat northward from the tropics. The Gulf Stream surface current is a western boundary current, one of the strongest, producing a current that is warm, deep, fast, and relatively salty. As a boundary current, it separates open-ocean water from coastal water. The California Current is an eastern boundary current and is broad, slow, cool, and shallow. Eastern boundary currents are often associated with upwelling, a characteristic which brings cold, nutrient-rich water from the depths up to the surface. The Somali Current, off Africa's eastern coast, is unusual because it reverses direction twice a year. From May to October it runs north; from November to April it runs south. Oceanographers express ocean current flow in millions of cubic meters per second. A large current, such as the Gulf Stream south of Nova Scotia, transports more than 150 million cubic meters per second. By contrast, the Mississippi River's average flow is only about 0.02 million cubic meters per second, roughly one ten-thousandth the flow of the Gulf Stream. Below is an alphabetical listing of the major ocean currents of the world.

- [1] **Agulhas Current** – A current flowing southwestward along the southeast coast of Africa. The Agulhas Current is well defined and narrow and one of the swiftest currents in the world.
- [2] **Alaska Current** – A current that flows generally northwestward along the northwest coast of North America. It contains water from the *North Pacific Current* and is therefore warmer than the water through which it flows.
- [3] **Aleutian Current** – A current that flows eastward between the *North Pacific Current* and the Aleutian Islands; a

- branch of the *Kuroshio Extension*.
- [4] **Antarctic Circumpolar Current** – A current that flows eastward completely around Antarctica, caused by the west-wind surface drift.
 - [5] **Antilles Current** – Represents the northern branch of the *North Equatorial Current* flowing along the northern side of the Greater Antilles and joins the *Florida Current* to form the *Gulf Stream*.
 - [6] **Benguela Current** – The northward-flowing current off the southwest coast of Africa located between 35 degrees south latitude and 15 degrees south latitude.
 - [7] **Brazil Current** – A warm saline current that flows southward along the coast of Brazil representing a continuation of the *South Equatorial Current*.
 - [8] **California Current** – An ill-defined current flowing southward along the west coast of the United States representing the major branch of the *Aleutian Current*.
 - [9] **Canary Current** – The cool current that flows southwestward along the northwest coast of Africa from the Canary Islands to the Cape Verde Islands.
 - [10] **Cape Horn Current** – The section of the west-wind surface drift that flows eastward near Cape Horn and then northeastward to become the *Falkland Current*.
 - [11] **Caribbean Current** – The strong current flowing westward in the Caribbean Sea through the Yucatan Channel, where it turns north and then east toward the Straits of Florida.
 - [12] **Cromwell Current** – An eastward-setting equatorial undercurrent in the Pacific Ocean, extending from about 150 degrees east longitude to 92 degrees west longitude. Also known as the *Cromwell Undercurrent*.
 - [13] **Cromwell Undercurrent** – See *Cromwell Current*.
 - [14] **Davidson Current** – A Pacific Ocean countercurrent that sets northward in winter along the west coast of the U.S. from northern California to at least 48 degrees north latitude.
 - [15] **East Africa Coast Current** – A seasonal current off the Somali coast that is fed during the Northern Hemisphere summer by part of the *South Equatorial Current* and flows northeastward as a strong, narrow current to feed the *Monsoon Current* in the northwest Indian Ocean; it almost disappears in winter, reversing to a broad, weak southwestward flow down the Somali coast. Also see *Samoli Current*.
 - [16] **East Australia Current** – A broad, strong current that flows south and southeastward along the east coast of Australia between 20 degrees south latitude and 45 degrees south latitude, then northward along the west coast of New Zealand.
 - [17] **East Greenland Current** – A cold current that carries water of low salinity south and southwestward through the Denmark Strait between Iceland and Greenland.
 - [18] **East Kamchatka Current** – See *Kamchatka Current*.
 - [19] **Equatorial Countercurrent** – A current flowing eastward near the equator in all oceans, generally between the westward-flowing *North* and *South Equatorial Currents*.
 - [20] **Equatorial Current** – The name given to either of two currents, the *North Equatorial Current* or the *South Equatorial Current*.
 - [21] **Falkland Current** – A current flowing northward along the coast of Argentina, from 50 degrees south latitude to 35 degrees south latitude.
 - [22] **Florida Current** – A swift current (2-5 knots) that is fed by the *Yucatan Current* and flows eastward through the Straits of Florida north of Cuba, where it turns northward and joins the Antilles Current north of the Bahamas to form the *Gulf Stream*.
 - [23] **Guiana Current** – A current that flows northwestward along the northeastern coast of South America from Cape San Roque to the Lesser Antilles.
 - [24] **Guinea Current** – A current that flows eastward along the entire southern coast of West Africa, shifting north and south seasonally but always remaining above the equator.
 - [25] **Gulf Stream** – The warm ocean current of the North Atlantic Ocean. It originates in the *Westward Equatorial Current* caused by the trade winds, but is deflected northward by the coast of South America into the Gulf of Mexico; issuing thence, it follows approximately the coast of North America to the island of Nantucket, where it is deflected more to the eastward.
 - [26] **Gulf Stream Countercurrent** – Any of several currents running counter to the *Gulf Stream*, on either side of it at different locations. It has also been predicted that this current represents a large undercurrent beneath the Gulf Stream, observations of which are still inconclusive.
 - [27] **Humboldt Current** – See *Peru Current*.
 - [28] **Japan Current** – See *Kuroshio Current*.
 - [29] **Kamchatka Current** – A current that carries Arctic water out of the Bering Sea into the Pacific Ocean, flowing southwestward on the eastern side of the Kamchatka Peninsula down to the northern Kurile Islands, where it joins the *Oyashio Current*. Also known as the *East Kamchatka Current*.
 - [30] **Kurile Current** – See *Oyashio Current*.
 - [31] **Kuroshio Countercurrent** – A current that flows southwestward, counter to and on the south side of the *Kuroshio Current*, about 70 kilometers south of Japan between 155 degrees east longitude and 160 degrees east longitude.
 - [32] **Kuroshio Current** – A fast-flowing (2-4 knots), narrow, and relatively deep current that flows northeastward from Taiwan to about 150 degrees east longitude, along the coast of Japan. Also known as the *Japan Current*.
 - [33] **Kuroshio Extension** – An ill-defined, eastward-flowing current that carries warm water from the Kuroshio Current

- into the North Pacific Ocean.
- [34] **Kuroshio System** – A circular chain of ocean currents in the Northwest Pacific Ocean, including part of the *North Equatorial Current*, the *Kuroshio Current*, the *Kuroshio Extension*, and the *North Pacific Current*.
 - [35] **Labrador Current** – A cold, weakly saline current that flows southward from the Davis Strait along the coasts of Labrador and Newfoundland, turning east and joining the *North Atlantic Current* southwest of Newfoundland.
 - [36] **Monsoon Current** – A seasonally variable current in the northwest Indian Ocean, in summer flowing generally eastward as the northern segment of the North Indian gyre, from the Arabian Sea to an area southeast of Sri Lanka.
 - [37] **Mozambique Current** – A current that is part of the western boundary current system of the Indian Ocean, flowing southward between Madagascar and the African mainland and along the coast to around 30 degrees south latitude.
 - [38] **North Atlantic Current** – A group of broad currents that form a slower-moving extension of the *Gulf Stream*, extending from southeast of the Grand Banks, off Newfoundland, to the Norwegian Sea. Also known as the *North Atlantic Drift*.
 - [39] **North Atlantic Drift** – See *North Atlantic Current*.
 - [40] **North Cape Current** – An extension of the *Norway Current* that flows northeastward around North Cape, the northernmost part of Norway, producing unstable weather conditions as it enters the icy Barents Sea.
 - [41] **North Equatorial Current** – The generic name given to the westward-flowing southern segment of the oceanic gyre in the North Pacific, Indian, and Atlantic Oceans; in the Indian Ocean it reverses its direction between May and September.
 - [42] **North Pacific Current** – A warm, eastward-flowing current in the Mid-Pacific Ocean between 25 degrees north latitude and 45 degrees north latitude, part of the system (beginning with the *Kuroshio Current* and the *Kuroshio Extension*) that carries warm water toward the east from the Western Pacific Ocean south of Japan.
 - [43] **Norway Current** – A branch of the *North Atlantic Current* that carries warm water north along the coast of Norway, ending in the *North Cape Current*. Also known as the *Norwegian Current*.
 - [44] **Norwegian Current** – See *Norway Current*.
 - [45] **Oyashio Current** – A cold current that flows southwestward along the eastern side of the Kurile Islands, from about 52 degrees north latitude to about 44 degrees north latitude, east of Hokkaido, where it turns eastward and joins the *Kuroshio Extension*. Also known as the *Kurile Current*.
 - [46] **Pacific Equatorial Countercurrent** – The equatorial countercurrent in the Pacific Ocean, which flows eastward between 3 degrees north latitude and 10 degrees north latitude.
 - [47] **Pacific North Equatorial Current** – A broad, slow current that flows westward entirely across the widest part of the Pacific Ocean between 10 degrees north latitude and 20 degrees north latitude.
 - [48] **Pacific South Equatorial Current** – A very broad current that flows westward across the Pacific Ocean between 20 degrees south latitude and 3 degrees north latitude; sometimes called the *Trade Drift* in its lower reaches, where it is slower than near the equator.
 - [49] **Peru Current** – A cold, broad current that flows northward along the west coast of South America, from about 40 degrees south latitude to 20 degrees south latitude. Also known as the *Humboldt Current*.
 - [50] **Somali Current** – Flowing off Africa's eastern coast along Yemen and Somali, this current is especially unusual because it reverses direction twice a year. Its surface circulation is strongly influenced by the seasonal monsoons and from November to April, during the Northeast Monsoon, the cyclonic gyre moves counterclockwise (southward). Then, during the Southwest Monsoon from May to October, the surface gyre moves clockwise (northward). Also referred to as the *East Africa Coast Current*.
 - [51] **South Atlantic Current** – The eastward-flowing southern segment of the South Atlantic gyre, continuous with the northern edge of the *Antarctic Circumpolar Current* between 40 degrees west longitude and 5 degrees west longitude at about the latitude of Buenos Aires. Also known as the *Southern Ocean Current*.
 - [52] **Southeast Drift Current** – The eastern segment of the North Atlantic gyre, flowing generally southward from about 45 degrees north latitude along the western side of the Iberian Peninsula and as far as the Canary Islands, where it becomes the *Canary Current*.
 - [53] **South Equatorial Current** – The generic name given to the westward-flowing northern segment of the oceanic gyre in the South Pacific, Indian, and Atlantic Oceans; in the Indian and Atlantic it lies well below the equator, but in the mid-Pacific it extends north of the equator to around 3 degrees north latitude.
 - [54] **South Indian Current** – The eastward-flowing southern segment of the South Indian gyre, continuous with the northern edge of the *Antarctic Circumpolar Current* between the *Agulhas* and *West Australian Currents*.
 - [55] **South Pacific Current** – The eastward-flowing southern segment of the South Pacific gyre, continuous with the northern edge of the *Antarctic Circumpolar Current* between New Zealand and Chile.
 - [56] **Southern Ocean Current** – See *South Atlantic Current*.
 - [57] **Spitsbergen Current** – A branch of the *Norway Current* that first flows northward toward Spitsbergen but then turns westward and joins the southward-flowing *East Greenland Current*.
 - [58] **Trade Drift** – See *Pacific South Equatorial Current*.
 - [59] **Tsushima Current** – The branch of the *Kuroshio Current* that flows through the Korea Strait into the Sea of Japan and then along the Japanese coast to the northern end of Honshu, where it flows eastward through the Tsugaru Strait at speeds of up to 7 knots, rejoining there the main branch of the *Kuroshio Current*.
 - [60] **Weddell Current** – An ocean current flowing eastward at around 50 degrees south latitude in the South Atlantic, north of the *Antarctic Circumpolar Current*.

- [61] **West Australia Current** – The eastern segment of the South Pacific gyre, flowing northward off the western coast of Australia from around 45 degrees south latitude to 15 degrees south latitude; it is a strong current, but its speed and depth vary considerably with the seasons.
- [62] **Western Equatorial Countercurrent** – A weak system of drift currents sometimes found flowing eastward in winter in the Western Atlantic Ocean near the equator.
- [63] **West Greenland Current** – The current that flows northward along the western coast of Greenland into Baffin Bay; it consists of water from the *East Greenland Current*, joined by some warmer Atlantic Ocean water, the latter keeping the coast relatively ice-free.
- [64] **Yucatan Current** – A rapid current that flows northward from Honduras through the Yucatan Channel between Mexico and Cuba, along the eastern edge of the Yucatan Shelf, and into the Gulf of Mexico and is generally considered the starting point of the *Gulf Stream*.

Ocean Discharge Guidelines (CWA Section 402) [EPA] — To implement section 403 of the *Clean Water Act (CWA)*, the U.S. Environmental Protection Agency (EPA) developed the Ocean Discharge Guidelines (40 CFR Part 125, Subpart M [45 FR 65942, October 3, 1980]), which specify the ecological, social, and economic factors to be used by permit writers when they evaluate the impact of a discharge on the marine environment. The 10 ocean discharge guidelines to be considered in determining whether unreasonable degradation of the marine environment will occur are as follows:

- [1] Quantities, composition, and potential bioaccumulation or persistence of the pollutants to be discharged;
- [2] Potential transport of the pollutants by biological, physical or chemical processes;
- [3] Composition and vulnerability of potentially exposed biological communities, including (a) unique species or communities, (b) endangered or threatened species, and (c) species critical to the structure or function of the ecosystem;
- [4] Importance of the receiving water area to the surrounding biological community, e.g., spawning sites, nursery/forage areas, migratory pathways, and areas necessary for critical life stages / functions of an organism;
- [5] The existence of special aquatic sites, including (but not limited to) marine sanctuaries/refuges, parks, monuments, national seashores, wilderness areas, and coral reefs/seagrass beds;
- [6] Potential direct or indirect impacts on human health;
- [7] Existing or potential recreational and commercial fishing;
- [8] Any applicable requirements of an approved Coastal Zone Management Plan (CZMP);
- [9] Such other factors relating to the effects of the discharge as may be appropriate; and
- [10] Marine water quality criteria.

Ocean Discharge Waiver — A variance from *Clean Water Act (CWA)* requirements for discharges into marine waters.

Ocean Dumping Permit — Under the *Ocean Dumping Ban Act* of 1988, which amended the 1972 *Marine Protection, Research, and Sanctuaries Act (MPRSA)*, no new permits for the dumping of sewage sludge or industrial waste are allowed, and all holders of existing permits were forced to cease ocean dumping of these materials on December 31, 1991.

Ocean Floor Sediment — Unconsolidated materials that settle and accumulate on the floor of the deep ocean. These materials can be fine muds and clays, quartz grains, dust, glacial debris comprised of microscopic shells of plants or animals, and substances precipitated directly from seawater.

Ocean Stratosphere — See *Cold-Water Sphere*.

Ocean Troposphere — See *Warm-Water Sphere*.

Oceanaut — A person trained to live in underwater installations and conduct, assist in, or be a subject of scientific research. Also called *Aquanaut*.

Oceanic — (1) (Oceanography) Of or relating to the ocean, for example an oceanic species. (2) (Geology) Of or relating to the areas of the ocean deeper than the littoral and neritic zones and beyond the *Epicontinental Zone*.

Oceanic Zone — (Oceanography) The biogeographic region of the open sea, as distinguished from that of the *Epicontinental Zone*.

Oceanicity — (Meteorology) A description of the specific extent to which the climate of an area is influenced by the ocean.

Oceanographic Equator — (Oceanography) The zone of maximum surface water temperature (generally above 28 degrees Celcius) of the ocean, generally lying above the equator, but lying slightly below the equator during the summer in the Indian Ocean, the Western Pacific, and the Western Atlantic.

Oceanographic Model — (Oceanography) A hypothetical representation of a given type of marine environment.

Oceans (World) — The oceans of the world include the North and South Atlantic Oceans, the North and South Pacific Oceans, the Arctic Ocean, the Antarctic Ocean, and the Indian Ocean. Figuratively, these are referred to as the *Seven Seas*.

Ocean Thermal Energy Conversion (OTEC) — Electricity generation by making use of the temperature difference (as much as 20EC, or 68EF, in the tropics) between the top and bottom layers of the ocean to convert a fluid to vapor, which in turn powers a turbine generator. Low efficiency and saltwater corrosion are two current technical problems with the implementation of OTEC.

Ocean Thermal Gradients — The temperature difference between deep and surface water in the oceans.

Oceanography — (1) The science relating to the study of the ocean. (2) Embraces all studies relating to the sea.

Odor Threshold — The minimum odor of a water sample that can just be detected after successive dilutions with odorless water. Also referred to as *Threshold Odor*.

Off-Channel Use — See *Offstream Use*.

Off-Line Reservoir — A reservoir constructed to the side of the main canal, usually in a natural drainage channel used to store surplus water runoff during the winter season for use during the irrigation season.

Off-Piste — (Sports) Existing or taking place on snow that has not been compacted into tracks.

Off-Site Use — A use of water away from the point of diversion or withdrawal.

Office of Ocean and Coastal Resource Management (OCRM) [NOS/NOAA] — An office within the *National Ocean Service (NOS)*, which is a part of the *National Oceanic and Atmospheric Administration (NOAA)*, U.S. Department of Commerce. The OCRM is responsible for implementing the *Coastal Zone Management Act (CZMA)* of 1972, as amended. The CZMA created two national programs:

- [1] **The National Coastal Zone Management Program (CZMP)** – The CZMP is a unique federal-state partnership for protecting, restoring, and responsibly developing the nation’s important and diverse coastal communities and resources. This is the mission of the CZMP and its 33 state and territory-based Coastal Management Programs. Through NOAA’s responsibilities under the CZMA, the OCRM works with the coastal and Great Lakes states and U.S. island territories to develop and implement these Coastal Management Programs. Under these programs, states and territories agree to work toward balancing the conservation and development of coastal resources using state and territorial management authorities, thereby providing for the sustainable development of the nation’s coasts.
- [2] **The National Estuarine Research Reserve System (NERRS)** – Estuaries – the fragile fringe along the coasts where fresh and saltwater mix – are some of the nation’s most important coastal resources. Keeping estuaries healthy is vital for keeping coasts healthy, but this requires an understanding of how estuaries function and interact with inland water bodies as well. Through the reserve system, OCRM works with the coastal states and territories to set aside representative estuaries for long-term research, education, and stewardship. Twenty-five National Estuarine Research Reserves have been designated in coastal states. The NERRS provides data and information to Coastal Management Program managers so that they can make better decisions about how to balance coastal conservation and development in their states and territories.

To carry out NOAA’s responsibilities under the Coastal Zone Management Act, the OCRM works directly with coastal states and territories to support the development of new Coastal Management Programs and National Estuarine Research Reserves, provide technical and financial assistance to coastal program and reserve operations, undertake projects with program-wide or system-wide benefits, integrate information from all of the Coastal Management Programs and National Estuarine Research Reserves to support activities at the national level, and promote coastal stewardship on a variety of critical coastal issues. Such issues include: coastal habitat protection and restoration; coastal hazards; public access to the shore for recreation; sustainable development of coastal communities, including urban waterfronts; and polluted runoff (also known as nonpoint source pollution or runoff pollution). The OCRM Strategic Plan provides a detailed description of the goals and objectives of the office. This plan incorporates key concepts from the CZM Strategic Plan and Reserve System Action Plan. OCRM consists of the Director’s office and two divisions: (1) The Coastal Programs Division (CPD) administers the National Coastal Zone Management Program; and (2) The Estuarine Reserves Division (ERD) administers the National Estuarine Research Reserve (NERR) Program and the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET).

Office of Water [EPA] — See *National Water Program [EPA]*.

Office of Wetlands, Oceans, and Watersheds (OWOW) [EPA] — The *U.S. Environmental Protection Agency (EPA)* Office of Wetlands, Oceans, and Watersheds focuses on a watershed approach to manage, protect, and restore the water resources and aquatic ecosystems of our marine and fresh waters. This strategy is based on the premise that water quality and ecosystem problems are best solved at the watershed level and that local citizens play an integral role in achieving clean water goals. Through its many programs, OWOW provides technical and financial assistance and develops regulations and guidance to support the watershed approach. OWOW is one of four program offices within the Office of Water at EPA Headquarters in Washington, D.C. The Office provides leadership, policy direction, and technical and financial support to ten EPA regions and the states, tribes, and territories that implement aspects of our programs. OWOW also collaborates with other federal agencies with related missions as well as local government, the private sector, and non-profit organizations. The OWOW consists of three principal divisions and a number of branches, as shown below:

- [1] Wetlands Division
 - Wetlands and Aquatic Resources Regulatory Branch
 - Wetlands Strategies and State Programs Branch
- [2] Assessment and Watershed Protection Division
 - Watershed Branch
 - Monitoring Branch
 - Nonpoint Source Control Branch
- [3] Oceans and Coast Protection Division
 - Marine Pollution Control Branch
 - Coastal Management Branch

The following provides specific information on the OWOW’s various programs:

- [1] **Wetlands Program** – The enduring mission of the OWOW’s Wetlands Program is to encourage and enable others to act effectively in protecting and restoring the nation’s wetlands and associated ecosystems, including shallow open waters and free-flowing streams. In doing so, the program engages in two principal categories of activities – establishing national standards and assisting others to meet them. EPA serves specifically:
 - As a partner, providing support for both regulatory and non-regulatory wetlands protection efforts;
 - As a promoter and distributor of sound wetlands science as the technical basis for effective wetlands decision making;

- In an advisory capacity for State and Tribal wetlands programs and for Clean Water Act Section 404 permit decisions;
 - As the developer of national wetlands standards and policies; and
 - As a regulator to back up our State and Local partners and ensure that national standards are lawfully applied.
- [2] **Oceans and Coastal Protection Program** – The Oceans and Coastal Protection Division’s vision for the future is that coastal and marine resources are successfully managed, protected, and restored, through collaborative efforts, to sustain healthy biological communities. OCPD’s mission is to improve the quality of coastal and marine ecosystems in the face of growing watershed threats. To accomplish this, we will bring to bear our leadership capabilities to catalyze public and private cooperative actions, take steps to prevent and control pollution, and set measurable goals to chart our progress and improve our programs.
- [3] **Watershed Protection Program** – The OWOW’s Watershed Protection Approach is a strategy for effectively protecting and restoring aquatic ecosystems and protecting human health. This strategy has as its premise that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual waterbody or discharger level. Major features of a Watershed Protection Approach are: targeting priority problems, promoting a high level of stakeholder involvement, integrated solutions that make use of the expertise and authority of multiple agencies, and measuring success through monitoring and other data gathering.

The duties and responsibilities of the OWOW are based on the following legislative and other authorities for carrying out its programs:

- Clean Water Act (CWA)
- Ocean Dumping Ban Act (ODBA)
- Coastal Zone Act Reauthorization Amendments (CZARA)
- London Convention (LC)
- Marine Plastics Pollution Research and Control Act (MPPRCA)
- Shore Protection Act (SPA)
- Marine Protection, Research, and Sanctuaries Act (MPRSA)
- Act to Prevent Pollution from Ships (APPS)
- International Convention for the Prevention of Pollution from Ships (MARPOL)
- Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA)

In partnership with others, the OWOW operates the Internet-based *Watershed Information Network (WIN)*. WIN is a roadmap to consolidated watershed information and services that can help communities protect and restore water quality. WIN provides ready access to information on such topics as: (a) what a watershed is, (b) how to find a specific watershed, (c) available training for watershed practitioners, and (d) financing watershed protection and restoration activities. Included in WIN is the Index of Watershed Indicators, which compiles information on the health of aquatic resources in over 2,100 watersheds in the 48 contiguous states. Entering a “place” (such as ZIP code, county, tribe, or school) in WIN will generate specific data about a watershed and show the user how they can get involved in watershed issues. OWOW has also modernized EPA’s computerized STOrage and RETreival system for water quality data, STORET, so that it more effectively meets the emerging information needs for watershed protection. New STORET will serve as EPA’s principal repository for chemical data, biological community information, fish tissue analyses, and aquatic habitat evaluations for fresh and marine water. PC-based and user-friendly, new STORET requires quality assurance information to ensure the integrity of the data in the system. Data in new STORET will soon be accessible via the Internet. OWOW is also developing a variety of tools to help states and other partners geographically display and manage their water information. OWOW’s Watershed Information Network provides consolidated watershed information and services that can help communities protect and restore water quality.

Offset — (Irrigation) The difference between the controlled variable and the referenced input, for example, in a canal system, the difference between the actual water level in the canal and the water level at design flow.

Offset Stream — A stream that has been displaced laterally or vertically as a result of faulting.

Offshore — (1) Situated off the shore but within waters under a country’s control, as offshore fisheries. (Geology) (1) Of or related to the comparatively flat, completely submerged zone that extends from the low-tide mark to the seaward edge of the *Continental Shelf*. (2) The direction that is seaward from the shore.

Offshore Terrace — (Geology) A wave-built terrace of coarse sand and gravel that occurs in the offshore region.

Offshore Water — (Oceanography) The sea between the breaker zone and the edge of the *Continental Shelf*.

Offstream (Off-Stream) Use — (1) Water withdrawn from a surface water source for uses such as irrigation, municipal and industrial (*M&I*) water supply, steam electric power generation, etc. (2) Water withdrawn or diverted from a ground or surface-water source for use at another place. Examples of offstream use include public-water supply, industry, irrigation, livestock, thermoelectric power generation, and other uses. Also referred to as *Off-Channel Use*.

Ogee — A reverse curve shaped like an elongated letter *S*. The downstream faces of overflow dams are often made in this shape.

Oil-Field Brine — Water having a high concentration of calcium and sodium salts; found in rocks during deep oil drilling.

Oil Skimmer — A device that collects and removes oil from a water surface. Ropes, belts, rotating drums, and similar devices are used as adhering surfaces for the oil, and the oil is pressed out or scraped off into a holding tank.

Oil Slick — A layer of oil floating on the surface of water.

Oil Spill — An accidental or intentional discharge of oil which reaches bodies of water. Can be controlled by chemical dispersion, combustion, mechanical containment, and/or adsorption. Spills from tanks and pipelines can also occur away from water bodies, contaminating the soil, getting into sewer systems and threatening underground water sources.

- Old** — (1) (Geology) Having become slower in flow and less vigorous in action, typically used to describe the state of a river. (2) (Geography/Topography) Having become simpler in form and of lower relief; well advanced toward reduction by running water to the lowest level possible. Used of topographic features or a landform.
- Old Age** — (1) The developmental stage at which the efficiency of a stream is reduced, so that the load it receives is greater than it can carry, and *Aggradation* becomes dominant. (Geology) (2) In the topographic development of a landscape or area, the last stage in the cycle of erosion, characterized by the reduction of the surface almost to base level and by landforms marked by simplicity of form and subdued relief. Also referred to as *Topographic Old Age*. (2) In the development of a shore or coast, a stage that is characterized by a broad, wave-cut platform, a gently sloping sea cliff, and a coastal area approaching *Peneplanation*.
- Old Field** — Cropland that is no longer used to produce an agricultural crop and that has been allowed to revert to natural plant cover.
- Old Growth** — (1) Forests that either have never been cut or have not been cut for many decades. (2) Forests characterized by a large percentage of mature trees. (3) A late stage of forest succession. Although the specific characteristics of old-growth stands vary with species composition and history, some commonly expected attributes in mesic forests on productive sites include: an abundance of large trees at least 180 to 200 years old; a multi-layered, multi-species canopy dominated by large overstory trees with moderate to high closure; numerous trees with broken tops, snags, and large logs.
- Old Ice** — A term for sea ice that has survived at least one summer's melt and shows smoother features than first-year ice.
- Old Lake** — (1) A lake in an advanced stage of infilling by sediments or vegetation. (2) A *Eutrophic* or *Dystrophic* lake. (3) A lake whose shoreline is in an advanced stage of development.
- Old Snow** — A term for deposited snow in which most of the original crystal shapes have been lost as a result of metamorphism. Also referred to as *Firn Snow*.
- Oligohaline** — Term to characterize water with salinity of 0.5 to 5.0‰ (parts per thousand), due to ocean-derived salts.
- Oligomictic Lake** — A lake that circulates only at irregular intervals, when abnormal cold spells occur.
- Oligopelic** — (Geology) Of or related to a lake bottom deposit containing very little clay.
- Oligosaline** — Term to characterize water with salinity of 0.5 to 5.0‰ (parts per thousand), due to land-derived salts.
- Oligotrophic (Water)** — (1) Reservoirs and lakes which are nutrient poor and contain little aquatic plant or animal life. (2) Pertaining to a lake or other body of water characterized by extremely low nutrient concentrations such as nitrogen and phosphorous and resulting very moderate productivity. Oligotrophic lakes are those low in nutrient materials and consequently poor areas for the development of extensive aquatic floras and faunas. Such lakes are often deep, with sandy bottoms and very limited plant growth, but with high dissolved-oxygen levels. This represents the early stages in the life cycle of a lake. Degrees of *Eutrophication* typically range from *Oligotrophic* water (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hypereutrophic* water (minimum transparency, maximum chlorophyll-a, maximum phosphorus). Also see *Carlson's Trophic State Index (TSI)* and *(Mean) Trophic State Index (TSI)*.
- Oligotrophic Lake** — A lake that is deficient in plant nutrients and characterized by an abundance of dissolved oxygen in its lower layer.
- Ombrometer** — See *Rain Gauge*.
- Ombrotrophic Bog** — An acidic wetland which receives all of its nutrients from *Atmospheric Deposition*.
- On-Fan Drainageway** — A drainageway or dendritic drainage system that rises on an alluvial fan, fan piedmont, or fan remnant and that may debouch on the fan piedmont or cross it.
- Once-Through Cooling Water** — Water (fresh or saline) that is withdrawn from a river, stream or other water body (man-made or natural), or a well, that is passed through a steam condenser one time, and then returned to the stream or water body some distance from the intake. Once-through cooling water is used to exchange the heat from the steam condensers commonly used in power production plants to the cooler water. Typically, such waters are required to be cooled in cooling ponds before returning to a stream or other body of water. Also referred to as *Open-Cycle Cooling*.
- One Hundred-Year Flood (100-Year Flood)** — (1) A flood having a one-percent chance of being equaled or exceeded in any given year. (2) The flood magnitude expected to be equaled or exceeded on the average of once in 100 years, with a one percent chance of being exceeded in any given year, determined by using the 100-year, 24-hour, storm unless gauging data is available and proved to be accurate. Having the same meaning as *Base Flood*, *1 percent Flood*, *One-Percent Chance Flood* or *Hundred-Year Flood*. Also see *X-Year Flood* and *Y-Duration Rain*.
- One-Percent Chance Flood** — See *One Hundred-Year Flood* or *Base Flood*.
- Onfarm** — Activities (especially growing crops and applying irrigation water) that occur within the legal boundaries of private property.
- Onlap** — (Geology) An arrangement of sedimentary layers within a depositional basin, in which the upper surface of each successively younger layer covers and extends beyond the margins of the older layer beneath it, as if deposited by a rising shoreline. Also referred to as *Transgressive Overlap*.
- Onshore** — Coming or moving from the water toward or onto the shore, as a breeze or prevailing wind.
- Oocyst** — An encysted oospore, either before or after division of its cell contents. See *Cryptosporidial (Crypto) Oocyst*.
- Ooze** — (1) To flow or leak out slowly, as through small openings. (2) To disappear or ebb slowly. (3) To exude moisture. (Geology) (4) Soft mud or slime. An area of soft, muddy ground, such as a bog, that develops from the flow of a spring or stream. (5) A soft, soupy mud or slime that typically overlies the bottom of a lake, river, or estuary. (6) A soft, calcareous or siliceous, deep-sea deposit that is composed mainly of clay minerals with at least 30 percent skeletal remains of marine organisms. (7) A layer of mud-like sediment on the floor of oceans and lakes, composed chiefly of the remains of microscopic sea animals.
- Opalized** — A rock whose original constituents have been replaced by opaline silica, a form of *Silica* (SiO₂) containing varying percentages of water.

Open — An unobstructed area of land or water.

Open Canopy — (Botany) Forest trees which are so scattered that there are frequent openings between tree crowns in the canopy.

Open Channel System — A system of conveyance channels where the top flow boundary is a free surface (e.g., canal systems).

Open-Cycle Cooling — The practice of withdrawing surface or well water to cool the condensers of an electric power plant or other industrial equipment, followed by release of the heated water to the ocean, a river, or a lake.

Open Drains — Open channels or large ditches spaced throughout an irrigation project to collect surface and subsurface drainage from adjacent farm land.

Open Lake — (1) Any lake that has an *Effluent Stream*. (2) Any lake that is free of ice, emergent vegetation, or artificial obstructions.

Open or Screened Interval — The length of the unscreened opening or of a well screen through which water enters a well, in feet below land surface.

Open-Pit Mining — (1) A form of operation designed to extract minerals that lie near the surface by removal of overburden and then removal of the minerals. (2) The process of removing mineral deposits that are found close enough to the surface so that the construction of tunnels (underground mining) is not necessary. The soil and strata that cover the deposit are removed to gain access to the mineral deposit. The primary environmental concerns related to this technique are the disposition of spoils removed to gain access to the deposit and the scoring of the landscape that remains following the complete removal of the mineral deposit. Erosion and water pollution are also concerns because runoff from the mining area is frequently rich in sediments and minerals which may pollute receiving streams. Furthermore, when the resulting pit extends below the water table, it may necessitate the removal of groundwater that infiltrates the mining pit, potentially altering the groundwater flow with possible implications on the water table and groundwater characteristics. Also referred to as *Strip Mining* or *Surface Mining*. Also see *Acid Mine Drainage*, *Dewater* and *Dewatering*, and *Yellowboy*.

Open River Channel — A navigation channel in a natural river with improvements limited to removal of obstructions and dredging to obtain adequate depths.

Open Sea — (Oceanography) The main or central part of an ocean or sea, not enclosed between headlands nor within the jurisdiction of a nation.

Open Space/Open Space Use — Refers to the current employment of land, the preservation of which conserves and enhances natural or scenic resources, protects streams and water supplies or preserves sites designated as historic pursuant to law.

Open System — Frozen ground in which additional groundwater is available through *Percolation* or by *Capillary Movement*.

Open Water — (1) Water in a lake that does not freeze over in winter. (2) Lake water that is free of emergent vegetation or artificial obstructions. (3) An area that, during a year with normal patterns of precipitation, has standing or flowing water for sufficient duration to establish an ordinary high water mark. Aquatic vegetation within the area of standing or flowing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. The term “open water” includes rivers, streams, lakes, and ponds. (4) (Oceanography) In regions of ice, a large region of navigable water that is mostly free of floating ice, with no more than 10 percent of its surface covered by ice.

Open Water Loop — Any process in which water is routed through a facility and then not reused, but discharged into a surface body of water after any appropriate treatment. Contrast with *Closed Water Loop*.

Operating Criteria — Design and institutional criteria that determine the operating limits of a water system.

Operating Criteria and Procedures (OCAP) [Nevada] — See *OCAP [Nevada]*.

Operation — Used to describe the performance of weather modification activities entered into for the purpose of producing, or attempting to produce, a certain modifying effect within one geographical area over one continuing time interval not exceeding one year.

Operation and Maintenance Costs (O&M) — (1) Average annual costs of project operation and normal maintenance. (2) The ongoing, repetitive costs of operating a water system; for example, employee wages and costs for treatment chemicals and periodic equipment repairs.

Operation, Maintenance, and Replacement Costs (OM&R) — The value of goods and services needed to operate a constructed project and make repairs and replacements necessary to maintain the project in a sound operating condition during its economic life.

Operational Concept — Mode of operating a canal with respect to location of priorities; usually supply oriented (upstream concept) or demand oriented (downstream concept).

Operational Losses — Losses of water resulting from evaporation and seepage.

Operational Spill — (1) A loss or waste of water in an irrigation system caused by operation of the system. (2) (Terminal Spill) Refers to those releases made at the terminal ends of the project conveyance or reservoir system. These canal or reservoir releases are not reused on the project's improved irrigated acreage.

Operator or Owner — Any public or private group or any individual to whom a *Water Producing Facility* (well) is assessed by the county assessor, or the person who owns the land upon which a water producing facility is located.

Optical Oceanography — (Oceanography) The branch of oceanography that is concerned with the optical properties of seawater and of natural light in seawater.

Optimal Corrosion Control Treatment — The corrosion control treatment that minimizes the lead and copper concentrations at users' taps while ensuring that the treatment does not cause the water system to violate any national primary drinking water regulations.

Optimum Moisture Content — (Geology) The water content of a soil mass that has been compacted to its maximum dry weight by a specified force.

Orbital Wave — (Hydraulics) A wave, such as an ocean wave, where the water particles move in a closed transverse and do not

translate.

Ordinary High Water Mark — The term as defined in decisions rendered by the courts of a state.

Ordinary High Water Mark [United States, 33 CFR 328.3(e)] — The term “ordinary high water mark” means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Ordinary Least Squares (OLS) — (Statistics) Mathematical procedures for attributing the variability of one quantity to changes in one or more other quantities. Often called “line fitting” or “curve fitting” since it produces an equation that can be used to predict the quantity of interest under many conditions. The concept is to attempt to fit a mathematical function to a series of data whereby the square of the error terms measuring the differences between the model estimates and actual observations is minimized, hence the term Ordinary Least Squares (OLS) is also used to describe this process. The standard of regression model is generally termed the *Classical Linear Regression (CLR) Model*. Also see *Regression Analysis*.

Ordinary Tide — (Oceanography) A tide that has periods of between 12 and 24 hours.

Ore — A mineral or aggregate of minerals from which a constituent of value can be profitably extracted.

Ordinary Low Water Mark — The term as defined in decisions rendered by the courts of a state.

Ordinate (Symbol Y) — (Mathematics) The plane Cartesian coordinate representing the distance from a specified point to the x-axis (*Abscissa*), measured parallel to the y-axis.

Organic — (1) Substances that come from animal or plant sources. Organic substances always contain carbon. (Inorganic materials are chemical substances of mineral origin.) (2) Being, containing, or relating to carbon compounds in which hydrogen is attached to carbon. Pertaining to, or derived from, living organisms. (2) Of or related to a substance that contains carbon atoms linked together by carbon-carbon bonds. All living matter is organic. Also see *Inorganic*.

Organic Acids — See *Volatile Acids*.

Organic Carbon (OC) — A measure of organic matter present in aqueous solution, suspension, or bottom sediments. May be reported as *Dissolved Organic Carbon (DOC)*, *Suspended Organic Carbon (SOC)*, or *Total Organic Carbon (TOC)*.

Organic Evolution — The theory that the various types of animals and plants have their origin in earlier types with the differences being due to modifications in successive generations.

Organic Load — (Water Quality) The amount of organic material added to a body of water. The amount of material, usually added by human activities, that must be mineralized or degraded within a particular environment.

Organic Mass — Volatile mass of the living substance is the difference between the *Dry Mass* and *Ash Mass* and represents the actual mass of the living matter. Organic mass is expressed in the same units as for ash mass and dry mass.

Organic Matter — (1) Plant and animal residues, or substances made by living organisms. All are based upon carbon compounds. (2) Chemical compounds of carbon combined with other chemical elements, and generally manufactured in the life processes of plants and animals. Most organic compounds are a source of food for bacteria and are usually combustible. (3) Any material of organic origin such as peat moss, ground bark, compost, and manure to be dug into the soil to improve its condition.

Organic Nitrogen — Nitrogen that is bound to carbon-containing compounds. This form of nitrogen must be subjected to mineralization or decomposition before it can be used by the plant communities in aquatic and terrestrial environments. This is in contrast with inorganic nitrogen, which is in the mineral state and more readily utilized by plant communities.

Organic Soil — Soil composed of predominantly organic rather than mineral material. Equivalent to *Histosol*.

Organic Waste — (1) Carbon-containing materials that are discarded into the environment and particularly into bodies of water. The term is often used as a euphemism for domestic sewage. (2) Waste material which comes mainly from animal or plant sources. Organic wastes generally can be consumed by bacteria and other small organisms. Inorganic wastes are chemical substances of mineral origin. Waste material which may come from animal or plant sources. Natural organic wastes generally can be consumed by bacteria and other small organisms. Manufactured or synthetic organic wastes from metal finishing, chemical manufacturing, and petroleum industries may not normally be consumed by bacteria and other organisms. Also see *Inorganic Waste* and *Volatile Solids*.

Organics — (1) A term used to refer to chemical compounds made from carbon molecules. These compounds may be natural materials (such as animal or plant sources) or man-made materials (such as synthetic organics). Also see *Organic*. (2) Any form of animal or plant life.

Organism — (1) Any living entity. (2) Any form of animal or plant life. (3) A form of life composed of mutually dependent parts that maintain various vital processes.

(Total) Organism Count — The total number of organisms collected and enumerated in any particular sample.

Organism Count/Area — The number of organisms collected and enumerated in a sample and adjusted to the number per area of habitat, usually square meter (m²), acre, or hectare. Periphyton, benthic organisms, and macrophytes are typically expressed in these terms.

Organism Count/Volume — The number of organisms collected and enumerated in a sample and adjusted to the number per sample volume, usually milliliter (mL) or liter (L). Numbers of planktonic organisms can be expressed in these terms.

Organochlorine Compounds — Any chemicals that contain carbon and chlorine. Organochlorine compounds that are important in investigations of water, sediment, and biological quality include certain pesticides and industrial compounds.

Organotins — Chemical compounds used in anti-foulant paints to protect the hulls of boats and ships, buoys, and pilings from marine organisms such as barnacles.

Orifice — (1) As used in water studies, an opening with a closed perimeter; is usually sharp edged, and of regular form in a plate, wall, or partition through which water may flow. An orifice is used for the measurement or control of water. (2) An opening (hole) in a plate, wall or partition. An orifice flange or plate placed in a pipe consists of a slot or a calibrated circular hole smaller

than the pipe diameter. The difference in pressure in the pipe above and at the orifice may be used to determine the flow in the pipe.

Orogenic — (Geology) Pertaining to the process of mountain-building, especially by the folding of the earth's crust. Also see *Diastrophic* and *Tectonic*.

Orographic — (1) (Meteorology) Of, relating to, or caused by mountains, as in an *Orographic Cloud*. (2) (Geology) A former term denoting features related to the structure and topography of mountains.

Orographic Ascent — (Meteorology) The upward displacement of air that is blowing over a mountain. Also referred to as *Orographic Lifting*.

Orographic Cloud — A cloud whose form and extent is determined by the disturbing effects of orography and mountains upon the passing flow of air. Because these clouds are linked with the form of the terrestrial relief, they generally move very slowly, if at all, although the winds at the same level may be very strong.

Orographic Desert — See *Rain Shadow Desert*.

Orographic Fog — (Meteorology) The supercooled air that condenses outward and is forced upward in the form of fog clouds as a result of a mountain in its path.

Orographic Precipitation — (1) Precipitation which results from the lifting of moist air over a topographic barrier such as a mountain range. The precipitation may occur some distance upwind and a short distance downwind, as well as on the barrier feature. (2) The precipitation resulting from the movement of a moisture-laden air mass across mountains or another inclined surface, like the face of a plateau. If sufficient water vapor is initially present in the air mass, precipitation falls upon the high ground which the air mass crosses. Substantial amounts of such precipitation are caused by mountain ranges athwart the prevailing direction of the air mass movement.

Orographic Rain — (Meteorology) The rain brought about by moist air or winds blowing over the rising slopes of mountains; caused by the cooling of the moist air after it is forced upward.

Orographic Storm — A rain or snow event that results from lifting (and consequent cooling) of an air mass over a mountain barrier, usually restricted to the windward (up wind) side of the mountains, and often producing hot, dry winds on the lee (down wind) side.

Orohydrography — A branch of *Hydrography* that deals with the relationship between mountains and drainage.

ORP — See *Oxidation Reduction Potential*.

Orr Ditch Decree [Nevada and California] — A tabulation or adjudication of Nevada (only) water rights for the Truckee River and its tributaries regulated through a series of reservoirs and irrigation canals, administered by the U.S. District Court Federal Water Master in Reno, Nevada. In combination with the *Truckee River Agreement [Nevada and California]* and the *Floriston Rates [California and Nevada]*, the Orr Ditch Decree currently represents the basis for operation of the Truckee River between its source (Lake Tahoe) and its terminus (Pyramid Lake). The Orr Ditch Decree (1944) incorporates the provisions of the Truckee River Agreement (1935), which provides for operation of storage facilities, especially Lake Tahoe, to satisfy Truckee River water rights. The Floriston rates constitute the chief operation objective on the Truckee River today and originated as a turn-of-the-century flow requirement for run-of-the-river users – hydropower and a pulp and paper mill. While the Orr Ditch Decree establishes water rights for entities within Nevada using the Truckee River's waters, the Truckee River Agreement, as part of that Decree, determines the operational mechanisms to satisfy those rights. Also see *Truckee River General Electric Decree [California]*.

Orthotolidine — Orthotolidine is a calorimetric indicator of chlorine residual. If chlorine is present, a yellow-colored compound is produced. This reagent is no longer approved for chemical analysis.

OS3 — A narrow ridge of gravelly or sandy glacial outwash material deposited by a stream in an ice tunnel within a glacier. Also referred to as *Esker*.

OSHA — The Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA) is a law designed to protect the health and safety of industrial workers and also the operators of water supply systems and treatment plants. OSHA also refers to the federal and state agencies which administer the OSHA regulations.

Osmoregulation — The adjustment in the osmotic concentration of solutes in body fluids to environmental conditions, for example, when salmon migrate from salt to freshwater.

Osmosis — (1) The diffusion of a liquid, usually water, from a solution containing a higher concentration of dissolved substances, into a solution of lower concentration, through a semipermeable membrane. (2) The passage of a liquid from a weak solution to a more concentrated solution across a semipermeable membrane. The membrane allows the passage of the solvent (water) but not the dissolved solids (solute). This process tends to equalize the conditions on either side of the membrane. (3) The selective passage of liquids through a semipermeable membrane in a direction which tends to make concentrations of all substances on one side of the membrane equal to those on the other side. The semipermeable membrane allows the passage of water but prevents the passage of substances dissolved in the water. The water movement is from the more dilute solution toward the more concentrated solution, and will continue until the two solutions are equal in concentration. If pressure is applied to the more concentrated side, the flow of water will reverse, from the concentrated side to the more dilute side, a condition termed *Reverse Osmosis*.

Osmotic Lysis — The rupture of a cell placed in a dilute solution. For example, when a red blood cell is placed in distilled water, water tends to move into the cell because of the osmotic pressure generated as a result of the concentration of the materials inside the cell. As the amount of water increases within the cell, the cell membrane can no longer withstand the pressure, and ruptures.

Osmotic Potential — The work per unit quantity of pure water that has to be done to overcome the effect of ions in the soil solutions. Unlike the *Matric Potential*, it has little effect on movement of water in soils; its major effect is on uptake of water by plant roots.

Osmotic Pressure — The pressure exerted by the flow of water through a semipermeable membrane separating two solutions with

different concentrations of solute.

Osmotroph — An organism that obtains nutrients through the active uptake of soluble materials across the cell membrane. This class of organism, which includes the bacteria and fungi, cannot directly utilize particulate material as nutrients. Contrast with *Phagotroph*.

Other Water Use — Water used for such purposes as heating, cooling, irrigation (public-supplied only), lake augmentation, and other nonspecific uses. The water can be obtained from a *Public Water Supply System*, or may be self-supplied. Also see *Self-Supplied Water*.

Outcrop — (1) Subsurface formations which become exposed at the surface. (2) That part of the mineral formation that appears at the surface of the ground. It does not necessarily imply visible presentation of the mineral on the surface of the earth, but includes those deposits that are near to the surface.

Outcrop Water — Rain and surface water that seeps down through fault planes, old shafts, or surface drifts, or through porous and fissured rock that has been exposed at the surface.

Outfall — (1) The place where a sewer, drain, or stream discharges; the outlet or structure through which reclaimed water or treated effluent is finally discharged to a receiving water body. (2) The point, location or structure where wastewater or drainage discharges from a sewer, drain, or other conduit. The conduit leading to the final disposal point or area. See *Outfall Sewer*.

Outfall Sewer — A sewer that receives wastewater from a collection system or from a wastewater treatment plant and carries it to a point of ultimate or final discharge in the environment. See *Outfall*.

Outflow, also Outflows — (1) To issue or stream out, in or as if in a flow from a body of water. (2) Process of flowing out; includes all water that leaves a *Hydrologic System*.

Outflow Boundary — A storm-scale mesoscale boundary separating thunderstorm-cooled air (outflow) from the surrounding air, similar in effect to a cold front. Passage is marked by a wind shift and usually a drop in temperature. New thunderstorms often develop along outflow boundaries, especially near the point of intersection with another boundary (cold or warm front, another outflow boundary).

Outflow Channel — A natural stream channel that transports reservoir releases.

Outgrowth — (Meteorology) The offshoot of a main cloud, such as the anvil of a *Cumulonimbus Cloud*, due to relative cloud and jetstream movements at different levels.

Outlet — (1) Point where water exits from a stream, river, lake, reservoir, tidewater, or artificial drain. The mouth of a river where it flows into a larger body of water. (2) A stream or river that flows out of a lake or pond. (3) The channel through which such a stream flows. (4) The point at which a river or stream enters a large body of water, especially the sea. (5) Downstream opening or discharge end of a pipe, culvert, or canal.

Outlet Channel — A waterway constructed or altered primarily to carry water from man-made structures, such as terraces, tile lines, and diversions.

Outlet Discharge Structure — A structure built to protect the downstream end of a dam's outlet pipe from erosion and is often designed to slow the velocity of released water to prevent erosion of the stream channel.

Outlet Glacier — A stream of ice that flows outward from an ice sheet or ice cap through a mountain pass or valley, being forced to a channel or path by exposed rock.

Outlet Head — The place where water from a lake flows into an *Effluent Stream*.

Outliers — (Data Analysis) Data values in a time series which are significantly different from the series trend and/or other data values such that their inclusion may jeopardize the model's ability to fit the data. If such sample data values cannot be explained by other, external factors, then they should probably be omitted from the model estimation process altogether.

Outwash — (Geology) (1) A deposit of sand and gravel formed by streams of meltwater flowing from a glacier and laid down in stratified deposits. (2) Sand and gravel that has been removed from a glacier by meltwater streams and laid down beyond the margin of the glacier. Also referred to as *Glacial Outwash*, *Overwash* or *Outwash Drift*. (3) Soil material that has been transported down an incline by rainwater and deposited on more gently sloping land. (4) Stratified sand and gravel removed or washed out from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of an active glacier. The coarser material is deposited nearer to the ice.

Outwash Fan — (Geology) A fan-shaped deposit of glacial *Outwash* that has been laid down by meltwater streams in front of or beyond the terminal moraine of a *Glacier*.

Outwash Plain — A broad, gently sloping sheet of *Outwash*.

Ouzel, also Ousel — (Geology) (1) A water ouzel or water dipper. (2) A broad, extensive, flat or gently sloping sheet of glacial outwash formed in front of or beyond the terminal moraine of a glacier by the merging of *Outwash Fans*. Also referred to as *Frontal Plain*, *Outwash Apron*, *Sandur* or *Wash Plain*.

Overall Efficiency Pump — The combined efficiency of a pump and motor together. Also called the *Wire-to-Water Efficiency*.

Overall Project Efficiency — A term reflecting all of the losses experienced by the irrigation project. By definition: *Overall Project Efficiency* = Project Conveyance Efficiency *times* Farm Irrigation Efficiency, or Total Project Crop Water Requirement *divided by* Diversions Into Project for Irrigation (expressed as a percentage).

Overbank Flow — Water flow over the top of the *Bankfull Channel* onto the floodplain.

Overbank Storage — Water stored in the flood plain during flood flows.

Overburden — (1) The earth, rock, and other materials that lie above a desired ore or mineral deposit. Material that overlies a deposit of useful material, especially those deposits that are mined by surface mining techniques. (2) The loose soil, silt, sand, gravel, or other unconsolidated material overlying bedrock, either transported or formed in place; regolith.

Overcast — (Meteorology) Of the sky, more than 95% covered by clouds.

Overchute — A *Flume* (or bridge with sideboards) for passing flood water across an irrigation ditch or canal.

- Overdeepening** — (Geology) An erosive process whereby a glacier excessively deepens and widens an inherited preglacial valley to a level below that of the original surface.
- Overdraft** — (1) A condition that occurs in a groundwater basin when pumping exceeds recharge over an extended period of time. (2) The pumping of water from a groundwater basin or aquifer in excess of the supply flowing into the basin. This pumping results in a depletion or “mining” of the groundwater in the basin. (3) That quantity of water pumped in excess of the safe yield; the act of overdrawing a water supply or aquifer in amounts greater than replenishment. Also, the sustained extraction of groundwater from an aquifer at a rate greater than the recharge rate of the aquifer, resulting in a drop in the level of the water table. Also see *Groundwater Overdraft* and *Groundwater Mining*.
- Overdrafting** — The withdrawal of *Groundwater* at a rate in excess of replenishment.
- Overfall** — An abrupt change in stream channel elevations. Also, the part of a dam or weir over which the water flows.
- Overfall Dam** — A dam constructed to allow water to overflow the dam’s crest.
- Overfalls** — (Oceanography) A turbulent, disturbed water surface caused by a conflict of strong currents, by winds opposing a current, or by a current passing over a submerged ridge or shoal.
- Overfish** — (1) To fish (a body of water) to such a degree as to upset the ecological balance or cause depletion of living creatures. (2) To fish a body of water so extensively as to exhaust the supply of fish or shellfish.
- Overfishing** — The removal of a sufficiently large number of certain fish from a body of water such that breeding stocks are reduced to levels that will not support the continued presence of the fish in desirable quantities for sport or commercial harvest.
- Overflow** — (1) To flow or run over the top, brim, or banks. (2) To be filled beyond capacity, as a container or a waterway. (3) To flow out over the normal bank or channel onto the adjacent land. (4) The amount of such flow. (5) A device or structure over or through which excess water is allowed to flow.
- Overflow Ice** — Ice formed by water that rises through cracks in surface ice during high spring tides and then freezes.
- Overflow Rate** — (1) The flow into a basin divided by its total surface area, often expressed in units of gallons per day per square foot. It is used as a design parameter for settling basins. (2) (Water Quality) One of the guidelines for the design of settling tanks and clarifiers in treatment plants. Used by operators to determine if tanks and clarifiers are hydraulically (flow) over- or underloaded. Also called *Surface Loading*.
- Overflow Rate (GPD/sq ft)** — Equivalent to the Rate of Flow (GPD)/Surface Area (sq ft).
- Overflow Spring** — A type of gravity spring whose water overflows onto the land surface at the edge where a permeable deposit dips beneath an impermeable mantle of rock.
- Overflow Standpipe** — A standpipe located in a dam or other structure at an elevation that allows removal of excess water, preventing overflow.
- Overflow Stream** — (1) A stream filled by water that has overflowed the banks of another stream or a river. Also referred to as a *Spill Stream*. (2) A stream flowing out of a lake and carrying water to another stream or lake, or to the sea.
- Overhead Irrigation** — A pressurized irrigation system where water is distributed through pipes to the field and applied through a variety of sprinkler heads or nozzles. Pressure is used to spread water droplets above the crop canopy to simulate rainfall. These systems include portable and traveling guns, solid or permanent fixtures (overhead or pop ups), center pivots, and periodic moving systems. The efficiencies of these sprinkler systems range from 15 to 85 percent; however, the average of 70 percent is commonly used. Also referred to as *Sprinkler Irrigation*.
- Overland Flow** — (1) Surface runoff. (2) The flow of rainwater or snowmelt over the land surface toward stream channels. (3) The portion of surface runoff that flows downslope in thin sheets over the land surface toward stream channels. Also referred to as *Unconcentrated Flow*. (4) (Water Quality) The discharge of wastewater in such a way that it flows over a defined land area prior to entering a receiving stream. The movement over vegetated land fosters the removal of plant nutrients from the wastewater and constitutes a form of *Tertiary Wastewater Treatment*. After it enters a stream, it becomes *Runoff*.
- Overloaded Stream** — A stream carrying more sediment than it can transport, so that its velocity is decreased and it is forced to deposit part of its load.
- Overlying (Water) Right [California]** — Part of a decision made by the California Supreme Court in 1903 in the case of *Katz v. Walkinshaw* in which it was found that the English system of unconstrained pumping of groundwater was incompatible with the state’s dry climate. Therefore, the court decided that a rule of reasonable use must be applied to groundwater use. In addition, the court also established the concept of an overlying right in which all property owners above a common aquifer possess a shared right to reasonable use of the groundwater aquifer. Overlying rights, which are paramount to other water rights, are based on ownership and are analogous to riparian water rights in which the rights are correlative to users of the same groundwater source regardless of when individual withdrawals began. Also see *Doctrine of Mutual Prescription*.
- Overstory** — (Botany) The uppermost, or tree, part of a forest, formed by tree crowns; canopy. Also, the highest plant community within a given area, which in a sagebrush-grassland setting, would be the sagebrush.
- Overtum** — (1) The circulation of water layers in a lake or sea, occurring when cooled surface water sinks and mixes with water at the bottom. Also see *Isocline*. (2) The almost spontaneous mixing of all layers of water in a reservoir or lake when the water temperature becomes similar from top to bottom. This may occur in the fall/winter when the surface waters cool to the same temperature as the bottom waters and also in the spring when the surface waters warm after the ice melts. (3) The sinking of surface water and rise of bottom water in a lake or sea that results from changes in temperature that commonly occur in spring and fall. (4) One complete cycle of top to bottom mixing of previously stratified water masses. This phenomenon may occur in the spring or fall, or after storms, and results in uniformity of chemical and physical properties of water at all depths. Also referred to as *Turnover*, e.g., *Fall Turnover* and *Spring Turnover*.
- Overwash** — (1) The part of a wave that flows over the highest part of a berm or other structure and does not flow back to the sea or lake. (2) The water in restricted areas that flows over the low parts of barriers or spits, especially during high tides or storms.

See *Outwash*.

Overwash Mark — (Geology) A narrow, tongue-shaped sand ridge formed by an *Overwash* on the landward side of a berm or other structure.

Overwash Pool — (Oceanography) A tide pool that lies between a beach scarp and a berm, entered by the water only at high tide.

Ownership Entitlements [USBR] — The maximum acreage a landholder may directly or indirectly own and irrigate with Reclamation irrigation water.

Oxbow — (1) A looping stream meander having such an extreme bend that only a neck of land is left between the two parts of the stream. Also referred to as *Oxbow Stream* or *Horseshoe Bend*. Also see *Oxbow Lake*. (2) An abandoned meander in a river or stream, caused by *Neck Cutoff*. Used to describe the U-shaped bend in the river or the land within such a bend of a river. (3) (Geology) The horseshoe-shaped abandoned channel of a former oxbow stream, left when it cuts a new channel across the narrow meander neck. Also referred to as an *Abandoned Channel*. (4) (New England) Land completely or partially enclosed within a bend of a stream.

Oxbow Lake — (1) An abandoned meander isolated from the main stream channel by deposition, and filled with water. (2) A crescent-shaped lake formed when a stream cuts a new channel across the narrow neck of an *Oxbow*, which later becomes separated from the new main stream by the deposition of silt. Also referred to as *Oxbow*, *Horseshoe Lake*, *Moat* or *Loop Lake*.

Oxbow Stream — See *Oxbow*.

Oxidant — An oxidizing agent.

Oxidase — Any of a group of enzymes which catalyze oxidation reactions by using molecules of oxygen as the electron acceptor.

Oxidation (Oxidizing) — (1) The process of combining with oxygen. The combining of an element with oxygen. A chemical reaction that involves combination with oxygen or the loss of electrons. (2) Oxidation is the addition of oxygen, removal of hydrogen, or the removal of electrons from an element or compound. In the environment, organic matter is oxidized to more stable substances. The opposite of *Reduction*. (3) The process of increasing the positive valence or of decreasing the negative valence of an element or ion. (4) The process by which electrons are removed from atoms or ions, also, reduction. (5) (Water Quality) The addition of oxygen that breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means.

Oxidation Ditch — (1) (Water Quality) A shaped ditch, usually oval, with a revolving drum-like aerator which circulates the liquid within it and supplies air to it, to reduce the organic material by *Aerobic* action. (2) (Wastewater Treatment) The oxidation ditch is a modified form of the *Activated Sludge Process*. The ditch consists of two channels placed side by side and connected at the ends to produce one continuous loop of wastewater flow and a brush rotator assembly placed across the channel to provide aeration and circulation.

Oxidation Pond — A man-made body of water in which organic wastes are stabilized by the action of bacteria, used most frequently with other waste-treatment processes; a sewage lagoon.

Oxidation Reduction Potential (ORP) — (Wastewater Treatment) The electrical potential required to transfer electrons from one compound or element (the *Oxidant*) to another compound or element (the *Reductant*); used as a qualitative measure of the state of oxidation in water treatment systems. ORP is measured in millivolts, with negative values indicating a tendency to reduce compounds or elements and positive values indicating a tendency to oxidize compounds or elements.

Oxidized Organics — Organic materials that have been broken down in a biological process. Examples of these materials are carbohydrates and proteins that are broken down to simple sugars.

Oxidized Rhizosphere — A zone around a plant root system in *Hydric Soils* that shows staining from oxidation (“rust” stains).

Oxidizing Agent — Any substance, such as oxygen (O₂) or chlorine (Cl₂), that will readily add (take on) electrons. When oxygen or chlorine is added to wastewater, organic substances are oxidized. These oxidized organic substances are more stable and less likely to give off odors or to contain disease causing bacteria. The opposite is a *Reducing Agent*.

Oxycline Depth — Depth at which dissolved oxygen levels fall below a threshold value.

Oxygen — (Chemical Symbol O) An element occurring free as a colorless, tasteless, odorless diatomic gas, O₂ (ordinary oxygen), in the *Atmosphere*, of which it forms about 23 per cent by weight and about 21 per cent by volume, being slightly heavier than nitrogen. Oxygen combines with most elements, is essential for plant and animal respiration, and is required for nearly all combustion. Oxygen is the most abundant of all the elements on the earth’s surface, for, in addition to its occurrence free in air, it forms, in combination with *Hydrogen*, 88.812 per cent by weight of *Water* (H₂O) and nearly one-half by weight of the rocks composing the earth’s crust, being a constituent of silica, the silicates, the carbonates, the sulphates, etc. It is a constituent of all but a very few acids and, in general, the greater the proportion of oxygen with which an element combines, the more acidic does it become. It is also a constituent of a large proportion of organic compounds. Oxygen is also known in an allotropic, more active form, *Ozone*, O₃.

Oxygen Deficiency — An atmosphere containing oxygen at a concentration of less than 19.5 percent by volume. Also see *Oxygen Enrichment*.

Oxygen Deficit — (Water Quality) The difference between observed oxygen concentration and the amount that would theoretically be present at 100 percent saturation for existing conditions of temperature and pressure.

Oxygen Demand — The need for molecular oxygen (O₂) to meet the needs of biological and chemical processes in water. The amount of molecular oxygen that will dissolve in water is extremely limited; however, the involvement of oxygen in biological and chemical processes is extensive. Consequently, the amount of oxygen dissolved in water becomes a critical environmental constraint on the biota living in the water. The metabolism of large organisms like submerged plants and fish, the microorganisms engaged in decomposition, and spontaneous chemical reactions all require (demand) a portion of a limited resource, molecular oxygen. Also see *Biochemical Oxygen Demand (BOD)*.

Oxygen-Demanding Waste — Any organic material that will stimulate the metabolism of bacteria with a corresponding use of

Dissolved Oxygen (DO) when discharged into a natural waterway. Frequently used as a euphemism for domestic sewage. Also see *Oxygen Demand*.

Oxygen Depletion — The removal of *Dissolved Oxygen* from a body of water as a result of bacterial metabolism of degradable organic compounds added to the water, typically caused by human activities.

Oxygen Distribution — (Oceanography) The concentration of oxygen in seawater, which decreases from around 5 milliliters of oxygen per liter of seawater near the surface to practically nil at the greatest depths.

Oxygen Enrichment — An atmosphere containing oxygen at a concentration of more than 23.5 percent by volume. Also see *Oxygen Deficiency*.

Oxygen Minimum Layer — A subsurface layer containing little or no dissolved oxygen, especially when compared with the layers above and below.

Oxygen Sag Curve — A graph of the measured concentrations of *Dissolved Oxygen* in water samples collected (1) upstream from a significant *Point Source (PS)* of readily degradable organic material (pollution), (2) from the area of the discharge, and (3) from some distance downstream from the discharge, plotted by sample location. The amount of dissolved oxygen is typically high upstream, diminishes at and just downstream from the discharge location (causing a sag in the line graph) and returns to the upstream levels at some distance downstream from the source of pollution or discharge.

Oxygen Saturation Capacity — The maximum quantity of dissolved oxygen that a liquid exposed to the atmosphere can contain at a given temperature and pressure.

Oxygenate — To treat, combine, or infuse with oxygen.

Ozonation — (Water Quality) (1) The application of ozone to water for disinfection or for taste and odor control. The application of ozone to water, wastewater, or air, generally for the purposes of disinfection or odor control. (2) The use of *Ozone* gas (O_3) as a disinfectant to reduce the microbial load and to kill dangerous pathogenic bacteria in water. The treatment can be applied to a public drinking water supply before it enters the distribution system or to wastewater prior to its discharge into a receiving stream.

Ozonator — A device that applies *Ozone* to water for disinfection or for taste and odor control.

Ozone — (1) A faintly blue, irritating gas (O_3) occurring in minute quantities near the earth's surface and in larger quantities in the stratosphere as a product of the action of ultraviolet light of short wavelengths on ordinary oxygen. Ozone, concentrated in a layer about 15 miles above the earth, shields the earth from *Ultra-Violet (UV)* radiation in the range of 2,400-3,000 Angstroms by absorption. (2) A chemical compound composed of three oxygen atoms used in water disinfection. (3) A blue gaseous allotrope of oxygen (triatomic oxygen), O_3 , formed naturally from diatomic oxygen by electric discharge or exposure to ultraviolet radiation. It is an unstable, powerfully bleaching, poisonous oxidizing agent with a pungent, irritating odor, used to deodorize air, purify water, treat industrial wastes, and as a bleach. Increasingly, public utilities are converting from chlorine to ozone as a primary disinfectant. More potent than chlorine, ozone is the only known water supply disinfectant that is effective against the water-borne pathogen *Cryptosporidium*. In addition, ozone does not create health-threatening byproducts such as trihalomethanes (THMs) and haloacetic acids that are created in chlorination.

Ozone Hole — (1) A significant depletion of *Ozone* which occurs in the Southern Hemisphere spring in the lower stratosphere over Antarctica. This depletion is believed to result from man-made chlorofluorocarbons. (2) A large area over Antarctica recently discovered to have a seasonal drop in stratospheric ozone concentration of as much as 50 percent. It is linked to the formation of stratospheric ice clouds that release chlorine atoms from chlorofluorocarbons during the Antarctic winter. The chlorine is present in quantities that cause the extensive ozone depletion when the spring sunshine returns. Also see *Ozone Layer Depletion*.

Ozone Layer — (Meteorology) (1) A region of the upper atmosphere, between about 15 and 30 kilometers (10 and 20 miles) in altitude, containing a relatively high concentration of *Ozone* that absorbs solar ultraviolet radiation in a wavelength range not screened by other atmospheric components. (2) The layer of the upper atmosphere, from about 8 to 30 miles, where most atmospheric ozone is concentrated; it is now regarded as subject to depletion by industrial pollutants, such as fluorocarbons from aerosol sprays. Also referred to as the *Ozonosphere*.

Ozone Layer Depletion — The destruction of *Ozone* molecules in the *Ozone Layer* of the *Stratosphere* by chemical reactions with materials released by human activities. The main ozone-consuming chemicals are the chlorofluorocarbons (CFCs) and the halons, both of which are groups of chemicals that are extremely stable in the *Troposphere*, with typical atmospheric lifetimes of 60 to 100 years. If the CFC's or halons migrate to the stratospheric ozone layer, the ultraviolet radiation there is strong enough to break the molecules apart, releasing chlorine atoms (CFC's) or bromine atoms (halons) which react with and destroy ozone. Also referred to as *Ozone Depletion*.

Ozonosphere — See *Ozone Layer*.

P

Pack Ice — (Oceanography) Any free-floating sea ice that has been driven together into a more or less solid mass, from 50 meters to several kilometers across.

Package Treatment Plant — (Wastewater Treatment) A small wastewater treatment plant often fabricated at the manufacturer's factory, hauled to the site, and installed as one facility. The package may be either a small primary or a secondary wastewater treatment plant.

Packer Assembly — An inflatable device used to seal the *Tremie Pipe* inside the well casing to prevent the grout from entering the inside of the conductor casing.

Packed Tower — (Air Quality) An air pollution control device in which contaminated air is passed through a tower containing substances (packing) possessing large surface area. Water is passed over the packing material in a countercurrent fashion, i.e., in a direction opposite to the passage of the air, and the air contaminants are then absorbed into the liquid. Also referred to as *Absorption Tower*, *Spray Tower*, or *Tray Tower*.

Packed Tower Aeration — (Water Quality) (1) A process for the removal of organic contaminants from groundwater. The groundwater flows downward inside a tower filled with materials (the packing) over a large surface area. Air is introduced at the bottom of the tower and is forced upward past the falling water. Individual organic contaminants are transferred from the water to the air, according to the gas and water equilibrium concentration values of each contaminant. (2) A method of treating water to remove *Volatile Organic Chemical (VOCs)* contaminants. As water is mixed with air, VOCs move from water to air which then passes through carbon filters to trap the contaminants. Also referred to as *Air Stripping*.

Packer — (1) A device lowered into a well to produce a fluid-tight seal. (2) A device placed in a well for the purpose of sealing an annular space.

PAHs — See *Polycyclic Aromatic Hydrocarbons*.

Pahranagat National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Pahranaagat NWR is located approximately 90 miles north of Las Vegas, Nevada, at the northern end of the *Desert National Wildlife Refuge* and consists of 5,380 acres (8.4 square miles) of marshes, open water, native grass meadows and cultivated croplands. Established in 1964, the Pahranaagat NWR hosts numerous waterfowl and other migratory birds on the Pacific Flyway, which stretches from Alaska and Canada to Mexico. The name "Pahranaagat" comes from the Paiute Indian word meaning "place of many waters." Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Paired Terrace — (Geology) One of two equally elevated land surfaces that face each other from opposite sides of a stream valley and that represent remnants of the same floodplain or valley floor. Also referred to as *Matched Terrace*.

Palatable Water — Water at a desirable temperature that is free from objectionable tastes, odors, colors, and turbidity. Pleasing to the senses.

Paleobotany — The study of lake sediments, pollens, and microfossils to determine ancient climate and vegetation.

Paleoceanography — (Oceanography) The study of the history of ocean processes, especially the history of the life forms of ancient seas and their water conditions.

Paleocrystic Ice — Old sea ice, especially weathered polar ice that is at least 10 years old.

Paleolimnology — (1) The study of the conditions and processes of lakes in the geologic past. (2) The study of the history and sediments of existing lakes. (3) The study of the environmental history of inland waters, based primarily on analysis of biological, chemical, and physical characteristics of sediment cores.

Paleontology — (1) The science that deals with the life of past geological ages, as based on the study of the fossil remains of organisms. (2) The study of fossils of animal and plant life that existed in remote geological times. The study of these remains enables scientists to trace the evolutionary history of extinct as well as contemporary organisms. Paleontologists also play a major role in unraveling the stratigraphic mysteries of the earth's crust and by using detailed information on how fossils are distributed in sedimentary strata, they help prepare accurate geologic maps, which are essential in the search for oil, water, and minerals.

Paleopedology — The study of fossil soils. Also see *Pedology*.

Palimpsest — Of or relating to a type of drainage system in which a recent, anomalous drainage pattern has been superimposed on an older one.

Palmer Drought Severity Index (PDSI) — The PDSI was the first comprehensive drought index developed in the United States. It is a meteorological drought index based on a balance between moisture supply and demand and responds to weather conditions that have been abnormally dry or abnormally wet. The index is calculated based on precipitation and temperature data, as well as the local *Available Water Content (AWC)* of the soil, i.e., soil moisture. From the index's inputs, all the basic terms of the water balance equation can be determined, including evapotranspiration, soil recharge, runoff, and moisture loss from the surface layer. The index, however, is less well suited for mountainous regions or areas of frequent climatic extremes. Human impacts on the water balance, such as irrigation or drainage, are not considered. The index roughly ranges from extremes of -6 to +6,

with negative values denoting dry spells and positive values indicating wet periods. There are also a few values in the magnitude of -7 or +7. Ideally, the PDSI is designed so that a -4.0 in South Carolina has the same meaning in terms of the moisture departure from a climatological normal as a -4.0 in Idaho. The following shows the more typical PDSI classifications:

Palmer Drought Index	Drought Condition
4.00 or more	Extremely wet
3.00 to 3.99	Very wet
2.00 to 2.99	Moderately wet
1.00 to 1.99	Slightly wet
0.50 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.50 to -0.99	Incipient dry spell
-1.00 to -1.99	Mild drought
-2.00 to -2.99	Moderate drought
-3.00 to -3.99	Severe drought
-4.00 or less	Extreme drought

Also see *Drought Indexes (Indices)*.

Palustrine — (Ecology) (1) Pertaining to a *Marsh* or *Wetlands*; wet or marsh habitats. (2) Of or relating to a marshy habitat. Also referred to as *Palustral*.

Palustrine Wetlands — Used in the wetlands classification system by the *U.S. Fish and Wildlife Service (USFWS)* to refer to wetlands that are vegetated-dominated by trees, shrubs, herbaceous plants, mosses or lichens. See *Wetlands (General)*, *Wetlands (COE and EPA)*, *Wetlands (USFWS)*, *Wetlands (NRCS)*, *Wetlands, Palustrine*, and *Wetlands, Benefits*. See *Wetland and Deepwater Habitat Classification System*.

PAM — Primary Amoebic Meningoencephalitis.

PAMs — See *Polyacrylamides (PAMs)*.

Pan — (1) A basin or depression in the earth, often containing mud or water. (2) A natural or artificial basin used to obtain salt by evaporating brine. Also referred to as *Hardpan*.

Pan Evaporation — Evaporation in inches from a standard Weather Bureau Class A pan. See *Evaporation Pan*.

Pancake Ice — (Oceanography) Pieces of newly formed sea ice between 0.3 and 2.5 meters across, shaped by constant collisions in rough water into round, flat shapes with slightly raised edges.

Paralimnion — (1) The region along the shore of a lake, extending from the shoreline to the deepest limit of rooted vegetation. (2) (Ecology) The sum of all of the various factors that make up the portion of a lake in which vegetation flourishes. Derivative term includes *Paralimnetic*.

Parallax Inequality — (Oceanography) The variation in tidal range or in the speed of tidal currents that is caused by the constantly changing distance between the earth and the moon.

Parallel Drainage Pattern — A pattern of natural stream courses in which the streams and their tributaries are regularly spaced and flow parallel to one another over a large area.

Paralytic Shellfish Poisoning (PSP) — A pathological condition in humans caused by the consumption of certain marine mussels or clams that have fed on planktonic dinoflagellates belonging to the genus *Gonyaulax*. The mussels or clams become contaminated with a neurotoxin produced by the dinoflagellates, and subsequent consumption by humans results in respiratory or gastrointestinal distress. The condition occurs in conjunction with the phenomenon known as the *Red Tide*, a bloom of dinoflagellate population in marine waters.

Parameter — (1) A variable, measurable property whose value is a determinant of the characteristics of a system. (2) (Statistics) Fundamentally, the parameter represents the true value of the characteristic of a sample or population. The estimate of a parameter, called a statistic, is a measurement of a sample of the population. The parameters in an *Econometric Model (Regression Analysis)* describe the relationship between the variations in the *Dependent Variable*, or the variable to be explained, and the variations in the *Independent*, or *Explanatory Variable(s)*. For example, in the simple expression of cause and effect

$$Y_t = \alpha + \beta X_t + \epsilon_t$$

the constant term, α (*alpha*), and the coefficient term, β (*beta*), define the (fixed) parameters of this econometric model and will be tested, statistically, to determined if the relationship is valid, i.e., is there exists a causal (i.e., cause and effect) relationship, or if the variations in the dependent variable are based on chance (random).

Parametric Hydrology — A branch of hydrology in which the relationships among the physical parameters involved in hydrologic events are studied, analyzed, and used to synthesize other hydrologic events.

Parapet Wall — A solid wall built along the top of a dam for ornament, for the safety of vehicles and pedestrians, or to prevent overtopping.

Parent Material — The unconsolidated and more or less chemically weathered mineral or organic matter from which the *Solum* of soils is developed by *Pedogenic* processes.

Parhelic Circle — A luminous halo visible at the height of the sun and parallel to the horizon, caused by the sun's rays reflecting off atmospheric ice crystals. Also referred to as a *Parhelic Ring*.

Parhelion (Sun Dog) — A bright spot outside the 22 degree halo at the elevation of the sun caused by refraction of sunlight by ice crystals.

Parna Dune — An eolian dune built of sand size aggregates of clayey material that commonly occurs leeward of a playa.

Parshall Flume — A device used to measure the flow of water in an open channel. The flume narrows to a throat of fixed dimensions and then expands again. The rate of flow can be calculated by measuring the difference in *Head* (pressure) before and at the throat of the flume.

Partial Ballena — A spur, with a fully rounded crest, that is connected to an erosional fan remnant large enough that some relict fan surface is preserved on the remnant summit.

Partial Duration Flood Series — A list of all flood peaks that exceed a chosen base stage or discharge, without regard for the number occurring in a year. Also referred to as *Basic-Stage Flood Series* or *Floods Above a Base*.

Partial Penetration — (1) When the intake portion of the well is less than the full thickness of the aquifer. (2) A well constructed in such a way that it draws water directly from a fractional part of the total thickness of the aquifer. The fractional part may be located at the top, the bottom, or anywhere else in the aquifer.

Partial Pressure — In a mixture of gases, the pressure exerted by each gas independently of the other gases.

Partial-Record Station — A gaging site where discrete measurements of one or more hydrologic parameters are obtained over a period of time without continuous data being recorded or computed. A common example is a crest-stage gage partial record station at which only peak stages and flows are recorded.

Particle Count — (Water Quality) Results of a microscopic examination of treated water with a special "particle counter" that classifies suspended particles by number and size.

Particle Counter — A device which counts and measures the size of individual particles in water. Particles are divided into size ranges and the number of particles is counted in each of these ranges. The results are reported in terms of the number of particles in different particle diameter size ranges per milliliter of water sampled.

Particle Counting — A procedure for counting and measuring the size of individual particles in water. Particles are divided into size ranges and the number of particles is counted in each of these ranges. The results are reported in terms of the number of particles in different particle diameter size ranges per milliliter of water sampled.

Particle Size — The diameter (usually the intermediate diameter), in millimeters, of suspended sediment or bed material determined by either sieve or other sedimentation methods. The sedimentation-method utilizes the principle of Stokes Law to calculate sediment particle sizes. Sedimentation methods (pipet, bottom-withdrawal tube, visual-accumulation tube, Sedigraph) determine fall diameter of particles in either distilled water (chemically dispersed) or in native water (the river water at the time and point of sampling).

Particle Size Classification — Agrees with recommendations made by the *American Geophysical Union Subcommittee on Sediment Terminology*. The particle size classification is as follows:

- [1] **Clay** – 0.00024-0.004 millimeters (mm) (0.0000094-0.000158 inch);
- [2] **Silt** – 0.004-0.062 mm (0.000158-0.00244 inch);
- [3] **Sand** – 0.062-2.0 mm (0.00244-0.0787 inch); and
- [4] **Gravel** – 2.0-64.0 mm (0.0787-2.52 inches).

Particulate — A very small solid suspended in water which can vary widely in size, shape, density, and electrical charge. Colloidal and dispersed particulates are artificially gathered together by the processes of coagulation and flocculation.

Particulate Loading — The mass of *Particulates* per unit volume of water.

Particulate Matter — (Water Quality) In water pollution, particulate matter describes solid material in either the solid or dissolved states. Insoluble particulate matter includes particulate substances that either settle from water that is allowed to stand or are removed by passing the water through a filter. Sand, clay, and some organic matter constitute insoluble particulate matter. Dissolved substances that will neither settle if water is allowed to stand nor be removed by passage through a filter, but which will be recovered if the water is allowed to evaporate, are called dissolved particulate matter. Salt is an example of this type of particulate matter. In air pollution, particulate matter is used to describe either solid particles or liquid droplets that are carried by a stream of air or other gases.

Particulate Organic Matter (POM) — Material of plant or animal origin that is suspended in water. The amount of this type of material suspended in water can be estimated by first removing the suspended material from the water by filtration, followed by either a direct measurement of the amount of carbon retained on the filter or by estimating the amount of carbon present from the weight lost upon heating the filter in excess of 500EC (932EF). Generally, the greater the amount of particulate matter present, the more severe the water pollution problem.

Particulate Phosphate — That portion of the total amount of phosphate (PO_4^{-3}) suspended in water that is attached to particles and will not pass through a filter. The aggregates can be either inorganic or organic. This form of phosphate must be solubilized before it can be used as a plant nutrient.

Particulates — (1) Small particles of liquid or solid matter. (2) Very small solids suspended in water. They can vary in size, shape, density, and electrical charge and can be gathered together by *Coagulation* and *Flocculation*. Also see *Particulate* and *Particulate Matter*.

Particulate Transport — Movement of undissolved particles in subsurface water.

Parts Per Billion (ppb) — (1) The number of "parts" by weight of a substance per billion parts of water. Used to measure extremely small concentrations. (2) A measure of concentration; one part per billion equals one drop in 10,000 gallons (or one minute in

2,000 years). Also referred to as *Microgram per Liter (ug/L)*.

Parts Per Million (ppm) — (1) The number of “parts” by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations. Large concentrations are expressed in percentages. (2) Parts per million parts, a measurement of concentration on a weight or volume basis. This term is equivalent to milligrams per liter (mg/L), which is the preferred term. (3) A measure of concentration; one part per million equals one drop in 10 gallons (or one minute in 2 years). Also referred to as *Milligram per Liter (mg/L)*.

Parts Per Thousand (ppt) — An expression of concentration which indicates one unit is contained in a total of a thousands units. It is normally used to specify the salinity of water and commonly indicated by the symbol “‰”.

Parts per Trillion (ppt) — A measure of concentration; one part per trillion equals one drop in 10,000,000 gallons (or one minute in 2,000,000 years).

Pass-Through — (Wastewater Treatment) The passage of untreated pollutants through a *Publicly Owned Treatment Works (POTW)* which could violate applicable water quality standards or *National Pollutant Discharge Elimination System (NPDES)* effluent limitations.

Passive Solar Water Heater — A water heating system that does not require mechanical pumps or controls to create hot water for domestic use.

Patchiness — A descriptive term referring to the size and variety of specific assemblages of vegetative communities residing within a particular area.

Paternoster Lake — One of a series of small, circular lakes lying within rock basins in a glacial valley and connected by streams, rapids, or waterfalls, so that they resemble a rosary or a string of beads. Also referred to as *Rock-Basin Lake*, *Step Lake* or *Beaded Lake*.

Pathogens — (1) Disease-producing agents; usually applied to a living organism (i.e., biological, such as bacteria). Generally, any viruses, bacteria, or fungi that cause disease. (2) Microorganisms that can cause disease in other organisms or in humans, animals and plants. They may be bacteria, viruses, or parasites and are found in sewage in runoff from animal farms or rural areas populated with domestic and/or wild animals, and in water used for swimming. Fish and shellfish contaminated by pathogens, or the contaminated water itself, can cause serious illnesses.

Pathogenic Microorganisms — Organisms capable of producing disease. Also see *Pathogenic Organisms*.

Pathogenic Organisms — Organisms, including bacteria, viruses or cysts, capable of causing diseases (*Giardiasis*, *Cryptosporidiosis*, *Typhoid*, *Cholera*, *Dysentery*) in a host (such as a person). There are many types of organisms which do not cause disease. These organisms are called non pathogenic. Many beneficial bacteria are found in wastewater treatment processes actively cleaning up organic wastes.

Pathology — The study of disease.

PCBs (Polychlorinated Biphenyls) — A group of synthetic, toxic industrial chemical compounds once used in making paint and electrical transformers which are chemically inert and not biodegradable. PCBs were frequently found in industrial wastes, and subsequently found their way into surface and groundwaters. As a result of their persistence, they tend to accumulate in the environment. In terms of streams and rivers, PCBs are drawn to sediment, to which they attach and can remain virtually indefinitely. Although virtually banned in 1979, they continue to appear in the flesh of fish and other animals.

PCE — See *Perchloroethylene*. Also referred to as *Tetrachloroethylene* and *Perclene*.

Peak Flow — The maximum instantaneous discharge of a stream or river at a given location. It usually occurs at or near the time of maximum stage.

Peaking — Typically describes the peak water demand for a municipal water system and is expressed as a ratio of the base demand level, e.g., 2:1 peaking represents a peak demand that is twice the base demand.

Peak Load (Power) — The maximum load in a stated period of time. Usually it is the maximum integrated load over an interval of one hour which occurs during the year, month, week, or day. It is used interchangeably with *Peak Demand*.

Peak Use Rate — The maximum periodic rate of consumptive use (*Evapotranspiration*) of water by plants.

Peat — (1) A brownish, lightweight mixture of partly decomposed plant remains in which parts of plants are still recognizable. (2) Any mass of semi-carbonized vegetable tissue formed by partial decomposition in water of various plants, especially mosses of the genus *Sphagnum*. Peat varies in consistency from turf to slime. As it decomposes its color deepens, old peat being dark brown or black, and keeping little of the plant texture. According to its formation, it is known as *Bog Peat* (mosses), *Heath Peat* or *Meadow Peat* (grasses and sedges), *Forest Peat* or *Wood Peat* (trees), and *Sea Peat* (seaweeds). Also see *Peatland*.

Peat Bog — See *Bog* and *Peatland*.

Peatland — A type of *Ecosystem*, also referred to as a *Mire*, in which organic matter is produced faster than it is decomposed, resulting in the accumulation of partially decomposed vegetative material called *Peat*. In some mires peat never accumulates to the point where plants lose contact with water moving through mineral soil. Such mires, dominated by grasslike sedges, are called *Fens*. In other mires peat becomes so thick that the surface vegetation is insulated from mineral soil. These plants depend on precipitation for both water and nutrients. Such mires, dominated by acid-forming sphagnum moss, are called *Bogs*. Peatlands are most extensive in northern regions. They develop where drainage of water is blocked, precipitation is retained, and decomposition of organic matter is slowed. Some peatlands form when accumulated organic matter and sediments fill in a pond or basin above the level of the water table. Called *Raised Bogs*, these sphagnum-dominated basins become so high in acidity and low in groundwater minerals that sedges and grasses retreat to the edges. Less commonly, sphagnum moss may form a floating mat over the water, then thicken and support associated vegetation, mostly *Heaths*, and eventually reach the bottom. Such mires are called *Quaking Bogs*. Under certain conditions, especially deforestation, sedge and sphagnum invade higher ground. The peat they form becomes compressed and blocks the drainage of water. These are called *Blanket Mires* or *Moors*. Also see *Marshland*.

Pebble — A small stone, especially one worn smooth by erosion. (Geology) A rock fragment between 4 and 64 millimeters (0.16 and 2.51 inches) in diameter, especially one that has been naturally rounded.

Peclet Number — Relationship between the advective and diffusive components of solute transport; expressed as the ratio of the product of the average interstitial velocity and the characteristic length, divided by the *Coefficient of Molecular Diffusion*. Small values indicate diffusion dominates; large values indicate advection dominates.

Pediment — (Geology) (1) A broad, gently sloping rock surface at the base of a steeper slope, often covered with *Alluvium*, formed primarily by erosion. (2) A broad, flat or gently sloping, rock-floored erosion surface or plain of low relief, typically developed by subaerial agents (including running water) in an arid or semiarid region at the base of an abrupt and receding mountain front or plateau escarpment, and underlain by bedrock (occasionally by older alluvial deposits) that may be bare but more often partly mantled with a thin and discontinuous veneer of alluvium derived from the upland masses and in transit across the surface. The longitudinal profile of a pediment is normally slightly concave upward, and its outward form may resemble a bajada (which continues the forward inclination of a pediment). Unlike a *Bajada*, however, which it closely resembles, a pediment is a surface of erosion whereas a bajada is a surface of deposition. In fact, the top of a bajada often merges with trailing portions of a pediment.

Pedisediment — A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is, or was, being transported across a pediment (footslope).

Pedogenic (Pedogenesis) — The process of soil formation. Also see *Pedology*.

Pedology — The scientific study of soils, their origins, characteristics, and uses.

Pelagic — (1) Relating to the deeper regions of a lake that are characterized by deposits of mud or ooze and by the absence of aquatic vegetation. (Oceanography) (2) Referring to the open sea at all depths (pelagic animals live in the open sea and are not limited to the ocean bottom). (3) Of or relating to the open ocean, near the surface or in the middle depths, beyond the *Littoral Zone* and above the *Abyssal Zone*. (4) (Ecology) Of or relating to aquatic organisms that live in the ocean, without direct dependence on the shore or bottom or on deep-sea sediment.

Pelagic Zone — The area of open water beyond the *Littoral Zone*.

Pelagophilous — (Ecology) Living or thriving in open surface waters of the ocean. Derivative terms include *Pelagophile* and *Pelagophily*.

Pelagophyte — (Ecology) A plant that lives on the surface waters of the ocean.

Pelite — (Geology) A sedimentary rock composed of fine fragments, as of clay or mud.

Pellicular Water — Layers of water that adhere to and form a film on the surfaces of soil and rock particles in the zone of aeration. Also referred to as *Adhesive Water*, *Film Water* or *Sorption Water*.

Pendular Water — *Capillary Water* that forms rings around the points of contact between adjacent rock and soil particles in the *Zone of Aeration*.

Peneplain, also Peneplane — (Geology) A nearly flat land surface representing an advanced stage of erosion.

Penesaline — (Ecology) Describing an environment that is intermediate between a normal marine environment and a saline environment.

Peninsula — A piece of land that projects into a body of water and is connected with the mainland by an *Isthmus*.

Penitent — Referring to a jagged spike, consisting mainly of either ice or snow, that is produced by differential melting and evaporation as a result of exposure to intense solar radiation.

Penstock — (1) A gate or sluice used in controlling the flow of water. (2) A tube or trough for carrying water to a water wheel, or a pipe carrying water to an electric turbine.

Per Capita Water Use — The water produced by or introduced into the system of a water supplier divided by the total residential population; normally expressed in terms of gallons per person per day (gpcd).

Per Worker Water Use — The water withdrawn or used by businesses and industry on a per worker basis. Normally calculated as total commercial and industrial water use divided by the average number of full-time equivalent (FTE) employees during the period, or gallons per worker per day (gpwd).

Percent Composition (Percent of Total) — A unit for expressing the ratio of a particular part of a sample or population to the total sample or population, in terms of types, numbers, weight, or volume.

Percent of Normal (Drought Index) — One of the simplest measurements of rainfall for a location, a percent of “normal” figure is calculated by dividing the actual period precipitation by the normal precipitation, which is typically based on a historical average of a 30-year mean or average value. This figure is then multiplied by 100 percent to provide the drought index value. Normal precipitation for a specific location is always considered to be 100 percent; therefore, drought index numbers below 100 percent indicated various degrees of drought conditions. The percent of normal index, while easily understood and effective for assessing a single region or season, can be misunderstood as the concept of normal is a mathematical construct and does not necessarily correspond with what one should expect precipitation to be in any given year (i.e., the normal value may be merely an average of extreme conditions). Also see *Drought Indexes (Indices)*.

Percent Saturation — The amount of a substance that is dissolved in a solution compared with the amount that could be dissolved in the solution, expressed as a percent. Equivalent to the amount of substance that is dissolved x 100 percent. Amount that could be dissolved in solution.

Percent Sodium — The percent of cationic equivalents in a water which is attributable to sodium.

Perched Aquifer — An *Aquifer* that contains *Perched Groundwater*.

Perched Groundwater — (1) Unconfined *Groundwater* that is separated by an unsaturated zone from the main body of groundwater below. Also referred to as *Perched Water*. (2) Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater with which it is not hydrostatically connected. (3) Groundwater in a saturated zone

of material underlain by a relatively impervious stratum which acts as a barrier to downward flow and which is separated from the main groundwater body by a zone of unsaturated material above the main groundwater body.

Perched Streams — Perched streams are either *Losing Streams* or *Insulated Streams* that are separated from the underlying groundwater by a *Zone of Aeration*. Also see *Stream*.

Perched Groundwater Deposit — Groundwater occurring in an elevated aquifer or saturated zone, separated from the main body of groundwater at lower elevation by unsaturated rock.

Perched Lake — A *Perennial Lake* whose surface level is at an elevation substantially higher than the surface levels of other bodies of water associated with it.

Perched Spring — A spring issuing from a body of *Perched Groundwater*.

Perched Stream — (1) A stream that has a surface level higher than the water table and is separated from the groundwater lying below by an impermeable bed in the *Zone of Aeration*. (2) A stream that flows onto an antecedent hillside along the graded valley of a higher-order stream into which it runs.

Perched Water — See *Perched Groundwater*.

Perched Water Table — (1) The surface of a body of *Perched Groundwater*. Also referred to as *Apparent Water Table*. (2) The top of a *Zone of Saturation* that bottoms on an impermeable horizon above the level of the general water table in the area. Is generally near the surface, and frequently supplies a hillside spring.

Perching Bed — (Geology) A body of rock of low permeability that supports a body of perched groundwater.

Perchloroethylene (PCE) (Tetrachloroethylene) — A solvent often used for degreasing and in dry cleaning which sometimes makes its way into water wells and other groundwater supplies. Studies have shown that high concentrations of the chemical can cause liver and kidney damage, including cancer, in animals. In humans, however, not enough information is available to say it is a definite carcinogen. The U.S. Environmental Protection Agency's (EPA) safe drinking water standard for tetrachloroethylene is 0.005 parts per million (ppm). Also referred to as *Tetrachloroethylene* and *Perclene*.

Perclene — See *Perchloroethylene (PCE)* or *Tetrachloroethylene*.

Percolating Water — (1) Water that passes through soil or rocks under the force of gravity along the path of least resistance. Contrast with *Subsurface Flow*. (2) Underground water whose course and boundaries are incapable of determination. Waters which pass through the ground beneath the earth's surface without a definite channel. May be rainwater slowly infiltrating through the soil or water seeping through the banks or the bed of a stream, but these waters have left the flow of the stream so that they no longer may be characterized as a part of the stream flow. It is presumed that groundwater percolates.

Percolation — (1) (General) The gradual movement of a liquid through a porous medium. (2) The slow seepage of water into and through the ground. (3) The slow passage of water through a filter medium. (4) The movement, under *Hydrostatic Pressure*, of water through the interstices of a rock or soil or other porous material. Also, the movement of water within a porous medium such as soil toward the *Water Table* without a definite channel. (5) The entrance of a portion of the streamflow into the channel materials to contribute to groundwater replenishment. (6) (Mining) In the leaching treatment of minerals, a gentle flow of a solution through an ore bed to extract minerals.

Percolation, Deep — The amount of water that passes below the root zone of the crop or vegetation.

Percolation Path — The course followed by water moving or percolating through any permeable material or under a dam which rests on a permeable foundation.

Percolation Pond — Refers to a pond (usually man-made) designed to allow treated wastewater effluent to percolate slowly into the ground. The pond acts as a holding facility while gravity allows the water to percolate or seep through the soil or other unconsolidated medium into the local water table (usually the surficial aquifer).

Percolation Rate — The rate, usually expressed as a velocity, at which water moves through saturated granular material. Also applies to quantity per unit of time of such movement and has been used erroneously to designate *Infiltration Rate* or *Infiltration Capacity*.

Percolation Test — (1) A procedure to measure the drainage characteristics of the soil on a lot. Such tests are required in the proper design of septic tank drainfields. (2) A soil test to determine if soil will take sufficient water seepage for use of a septic tank.

Percolation Zone — On a *Glacier* or ice sheet, the area where some degree of surface melting occurs, but where the snow layer is not completely soaked through or brought up to melting temperature, and the meltwater refreezes within the same layer.

Perennial Crops — (Agriculture) Those plants that live and evapotranspire throughout the year (365 days).

Perennial Grass — (Ecology) A grass that lives for more than one growing season. All visible leaves die back each year, but the roots send out new growth in the spring. Perennial grass roots are typically deeper than those of annual grasses.

Perennial Lake — A lake whose basin is filled with water throughout the year, and whose level fluctuates very little.

Perennial Spring — A spring that flows continuously, rather than intermittently. Also referred to as a *Permanent Spring* or *Live Spring*.

Perennial Stream — (1) A stream that flows from source to mouth throughout the year. (2) A stream whose bed lies below the water table, so that the stream flows continuously throughout the year. Also referred to as a *Permanent Stream* or *Live Stream*. (3) A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Run-off from rainfall is a supplemental source of water for stream flow. Also see *Stream*.

Perennial Yield (Groundwater) — The amount of usable water of a groundwater reservoir that can be withdrawn and consumed economically each year for an indefinite period of time. It cannot exceed the sum of the *Natural Recharge*, the *Artificial* (or *Induced*) *Recharge*, and the *Incidental Recharge* without causing depletion of the groundwater reservoir. Also referred to as *Safe Yield*.

Perfected Water Right — (1) A completed or fully executed water right. A water right is said to have been perfected when all

terms and conditions associated with it have been fully accomplished, e.g., the diversion has been effected and the water applied to beneficial use. (2) A water right to which the owner has applied for and obtained a permit, has complied with the conditions of the permit, and has obtained a license or certification of appropriation. (3) A water right which indicates that the uses anticipated by an applicant, and made under permit, were made for *Beneficial Use*. Usually it is irrevocable unless voluntarily canceled or forfeited due to several consecutive years of nonuse. Also referred to as a *Certified Water Right*. Also see *Appropriation Doctrine*.

Perfected Water Permit — A permit issued after the permittee has initiated *Beneficial Use* of water in accordance with the terms and conditions of the conditional water permit. The perfected water permit is the instrument of conveyance of a water right.

Perfection — The process of meeting terms and conditions of a water right permitting process which results in a *Perfected Water Right*.

Perforated Crust — A snow crust marked by pits and hollows formed as a result of *Ablation*.

Perforation of Wells — (1) Holes in the casing of wells which allow water to flow into the well. (2) A series of openings in a well casing made either before or after installation of the casing to permit the entrance of water into the well.

Pergelation — The formation of *Permafrost*.

Perhumid Climate — A climate in which the supply of moisture through precipitation more or less consistently exceeds the need for water for evaporation and transpiration. C. W. Hornthwaite has defined this climatic type as one in which the moisture index, based upon a comparison of the humidity index with the aridity index, is 100 or more.

Periodic Spring — A spring that rises and falls periodically, as a result of natural siphon action.

Periodic Station — A site where stage, discharge, sediment, chemical, or other hydrologic measurements are made one or more times during a year, but at a frequency insufficient to develop a daily record.

Peripheral Stream — A stream that flows parallel to the edge of a glacier.

Periphyton — An assemblage of microorganisms (plants and animals) firmly attached to and growing upon solid surfaces, such as the bottom of a stream, rocks, logs, pilings, and other structures. While primarily consisting of algae, they also include bacteria, fungi, protozoa, rotifers, and other small organisms. Periphyton are useful indicators of water quality.

Perlite, also Pearlite — A natural volcanic glass similar to obsidian but having distinctive concentric cracks and a relatively high water content. In a fluffy heat-expanded form perlite is used as a lightweight aggregated, in fire-resistant insulation, and in soil for potted plants.

Permafrost — The part of the earth's surface that is permanently frozen. Permanently frozen subsoil, occurring throughout the polar regions and locally in perennially frigid areas. Also see *Tundra*.

Permafrost Table — The variable surface constituting the upper limit of *Permafrost*.

Permafrost Terrains — Terrains characterized by a wide range of slow downslope movements involving creep, such as rock glaciers and gelifluction, and by more rapid landslides and snow avalanches.

Permanent Above-Grade Fill — A discharge of dredged or fill material into waters of the United States, including wetlands, that results in a substantial increase in ground elevation and permanently converts part or all of the waterbody to dry land.

Permanent Control — A stream-gaging control which is substantially unchanging and is not appreciably affected by scour, fill, or backwater.

Permanent Extinction — The permanent drying up of a lake as a result of the destruction of the lake basin.

Permanent Hardness — Water hardness that cannot be reduced or removed by heating the water, a reflection of the presence of dissolved calcium, magnesium, iron and other divalent metal ions. These ions will react to form insoluble precipitates.

Permanent Ice Foot — A narrow strip of ice attached to a polar coast that does not melt completely in summer.

Permanent Monument — (Engineering) Fixed monuments or reference markers placed away from the dam which allow movements in the horizontal and vertical *Control Points* on the dam to be observed by using accurate survey procedures.

Permanent Spring — See *Perennial Spring*.

Permanent Stream — See *Perennial Stream*.

Permanent Water — A water source that stays constant throughout the year.

Permeability — (1) The capacity of soil, sediment, or porous rock to transmit water; the property of soil or rock that allows passage of water through it. (2) For a rock or an earth material, the ability to transmit fluids; the rate at which liquids pass through soil or other materials in a specified direction. It is measured by the rate at which a fluid of standard viscosity can move through a material in a given interval of time under a given *Hydraulic Gradient*. Permeability for underground water is sometimes expressed numerically as the number of gallons per day that will flow through a cross section of 1 square foot, at 60EF, under a hydraulic gradient of 100 percent. Permeability is equal to velocity of flow divided by hydraulic gradient. The following permeability terms apply:

Permeability	Drainage Condition
Very Slow	less than 0.05 inch per hour
Slow	0.05 to 0.20 inch per hour
Moderately Slow	0.20 to 0.80 inch per hour
Moderate	0.80 to 2.50 inches per hour
Moderately Rapid	2.50 to 5.0 inches per hour
Rapid	5.0 to 10.0 inches per hour

Very Rapid

More than 10.0 inches per hour

Permeability Coefficient — The rate of flow of water through a unit cross-sectional area under a *Unit Hydraulic Gradient* at the prevailing temperature (*Field Permeability Coefficient*), or adjusted to 15EC (59EF). See *Permeability*, above.

Permeability, Effective — Observed permeability of a porous medium to one fluid phase, under conditions of physical interaction between the phase and other fluid phases present.

Permeability, Intrinsic — (1) Relative ease with which porous medium can transmit a fluid under a potential gradient, as a property of the medium itself. (2) Property of a medium expressing the relative ease with which fluids can pass through.

Permeability Soil — The quality of a soil horizon that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon even though the others are permeable.

Permeable — (1) Having pores or openings that permit liquids or gases to pass through. (2) Having a texture that permits water to move through it under the head difference ordinarily found in groundwater.

Permeable Bed — (Geology) A porous reservoir formation through which oil, natural gas, or water can flow.

Permeable Soils — Soils that water can easily penetrate and spread through.

Permeate — To penetrate and pass through, as water penetrates and passes through soil and other porous materials.

Permissible Velocity — (Hydraulics) The highest velocity at which water may be carried safely in a channel or other conduit. Also, the highest velocity that can exist through a substantial length of conduit and not cause scouring of the channel. Also referred to as *Safe Velocity* or *Noneroding Velocity*.

Permit — (1) (General) A water right permit, water right, validated vested water right, water quality variance permit, groundwater discharge facility construction permit, or groundwater discharge permit that is granted, amended, extended, or renewed by the board and which may include conditions or qualifications. (2) (Water Right) A written document which grants authority to take unused water and put it to *Beneficial Use*. If all requirements of the permit are satisfied, then the permit for water appropriation can mature into a license or *Perfected Water Right*. (3) (Discharge) A legally binding document issued by a state or federal permit agency to the owner or manager of a point source discharge. The permit document contains a schedule of compliance requiring the permit holder to achieve a specified standard or limitation (by constructing treatment facilities or modifying plant processes) by a specified date. Permit documents typically specify monitoring and reporting requirements to be conducted by the applicant as well as the maximum time period over which the permit is valid. Also see *Application*, *Water Right*.

Permit, Water [Nevada] — The written permission from the state engineer to appropriate public waters for a beneficial use from a surface or underground source, at a specific point of diversion, under limited circumstances. If all requirements of the permit are satisfied, then the permit for water appropriation can mature into a license or *Perfected Water Right*. Also see *Permitted Water Right [Nevada]*, and *Application*, *Water Right*.

Permit System — (1) A general term referring to a system of acquiring water rights under state law whereby the state must issue a permit for a new use of water. (2) A system requiring all appropriators to obtain a permit from some administrative official or body before commencing the use of water. Although permit systems were at one time, generally associated with the eastern United States using the *Riparian Doctrine*, they are now found elsewhere as well. The permit system provides the centralized record keeping and control necessary for the efficient functioning of the appropriation system.

Permitted Water Right [Nevada] — The right to put surface or groundwater to beneficial use that is identified by a document issued by the Nevada State Engineer prior to the filing of satisfactory proof of “perfection of application” in accordance with Nevada Revised Statutes Chapter 533. If proof of beneficial use is accepted by the State Engineer, then the water right permit can be converted into a *Certificated Water Right*. If proof of beneficial use is not made to or accepted by the State Engineer, then the right to claim title to the water may cease. Also see *Application*, *Water Right*.

Permitted Well — A well from which water is used for other than a domestic use and which has received a permit for a *Beneficial Use* from the water regulatory body or other appropriate official.

Persistence — (1) The resistance to degradation as measured by the period of time required for complete decomposition of a material. (2) The relative ability of a chemical to remain chemically stable following its release into the environment. Persistent chemicals resist *Biodegradation* and thus are of greater concern in the treatment of water and wastes.

Persistent Emergent — *Emergent Hydrophytes* that normally remain standing at least until the beginning of the next growing season; e.g., cattails (*Typha* spp.) or bulrushes (*Scirpus* spp.).

Persistent Pesticides — Pesticides remaining in the environment for more than one growing season or for more than one year after applications.

Person — A natural person, a partnership, an association, a corporation, a municipality, of a state and any political subdivision thereof, and agency of the federal government.

Perspiration — The fluid, consisting of water with small amounts of urea and salts, that is excreted through the pores of the skin by the sweat glands; sweat.

Perspire — To produce sweat or salty water from glands in the skin. A natural way of cooling the body by the evaporation of water.

Pervious — Allowing passage through, as a material to water.

Pervious Paving — Paving material that allows water to penetrate to the soil below.

Pervious Zone — A part of the cross section of an *Embankment Dam* comprising material of high permeability.

Pesticide — (1) Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pests, or any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. (2) Any chemical agent used for the control of specific organisms, for example, *Insecticides*, *Herbicides*, *Fungicides*, miticides, and rodenticides.

Peterson Dredge — A device used to collect sediment samples for the identification of bottom-dwelling animals in lakes and streams. The device has the appearance of a closed metal cylinder sectioned in half through the long axis. Weights can be

attached to the outside of the cylinder sections to provide a deeper bite into the sediment. The Peterson dredge is particularly useful in the sampling of sediments that have a high content of sand and gravel. Also referred to as the *Peterson Grab*.

Petrify — To convert (organic matter) into stone or a substance of stony hardness by the infiltration of water and the deposition of dissolved mineral matter.

Petrochemicals — Chemical substances produced from petroleum in refinery operations and as fuel oil residues. These include fluoranthene, chrysene, mineral spirits, and refined oils. Petrochemicals are the bases from which *Volatile Organic Compounds (VOCs)*, plastics, and many pesticides are made. These chemical substances are often toxic to humans and the environment.

Petroleum Derivatives — Chemicals formed when gasoline breaks down in contact with groundwater.

Pfiesteria Piscicida — A toxic *Dinoflagellate* that has been associated with fish lesions and fish kills in coastal waters from Delaware to North Carolina. A natural part of the marine environment, dinoflagellates are microscopic, free-swimming, single-celled organisms, usually classified as a type of alga. The vast majority of dinoflagellates are not toxic. Although many dinoflagellates are plant-like and obtain energy by photosynthesis, others, including *Pfiesteria*, are more animal-like and acquire some or all of their energy by eating other organisms. First discovered in 1988 by researchers at North Carolina State University, *Pfiesteria piscicida* is now known to have a highly complex life-cycle with 24 reported forms, a few of which can produce toxins. Three typical forms are (a) amoeboid, (b) flagellated, and (c) encysted. A few other toxic dinoflagellate species with characteristics similar to *Pfiesteria* have been identified but not yet named. These are referred to as “*Pfiesteria*-like organisms,” and they occur from Delaware to the Gulf of Mexico. *Pfiesteria* normally exists in non-toxic forms, feeding on algae and bacteria in the water and in sediments of tidal rivers and estuaries. Scientists believe that *Pfiesteria* only becomes toxic in the presence of fish, particularly schooling fish like Atlantic menhaden, triggered by their secretions or excrement in the water. At that point, *Pfiesteria* cells shift forms and begin emitting a powerful toxin that stuns the fish, making them lethargic. Other toxins are believed to break down fish skin tissue, opening bleeding sores or lesions. The toxins or subsequent lesions are frequently fatal to the fish. Fish may also die without developing lesions. As fish are incapacitated, the *Pfiesteria* cells feed on their tissues and blood. *Pfiesteria* is not an infectious agent like some bacteria, viruses, and fungi. Therefore, fish are not killed by an infection of *Pfiesteria*, but rather by the toxins it releases, or by secondary infections that attack the fish once the toxins have caused lesions to develop.

pH (Hydrogen Ion Concentration, or Potential of Hydrogen) — (1) A convenient method of expressing the acidity or basicity of a solution in terms of the logarithm of the reciprocal (or negative logarithm) of the hydrogen ion concentration. The pH scale runs from 0 to 14; a pH value of 7.0 indicates a neutral solution. Values above 7.0 pH indicate basicity (basic or alkaline solutions); those below 7.0 pH indicate acidity (acidic solutions). Natural waters usually have a pH between 6.5 and 8.5. Because the units are derived from common logarithms, a difference of one pH unit indicates a tenfold (10^1) difference in acidity; similarly, a difference of two units indicates a hundredfold (10^2) difference in acidity. The term originally derived from “potential of hydrogen,” or hydrogen power. (2) A term indicating the hydrogen ion concentration of a solution, i.e., a measure of the solution’s acidity. The term (from French, *pouvoir hydrogène*, or literally, “hydrogen power”) is defined as the negative logarithm of the concentration of H^+ ions (protons): $pH = -\log_{10} [H^+]$, where $[H^+]$ is the concentration of H^+ ions in moles per liter (see *Mole*). Because H^+ ions associate with water molecules to form hydronium (H_3O^+) ions (see *Acid* and *Base*), pH also is often expressed in terms of the concentration of hydronium ions. In pure water at 22° Celsius (72° Fahrenheit), H_3O^+ and hydroxyl (OH^-) ions exist in equal quantities; the concentration of each is 0.107 moles/liter. Consequently, the pH of pure water is $-\log (0.107)$, which equals $\log 107$, or 7. If an acid is added to water, however, an excess of H_3O^+ ions is formed; their concentration can range between 0.106 and 0.10 moles/liter, depending on the strength and amount of the acid. Therefore, acid solutions have a pH ranging from 6 (for a weak acid) to 1 (for a strong acid). Inversely, a basic solution has a low concentration of H_3O^+ ions and an excess of OH^- ions, and the pH ranges from 8 (for a weak base) to 14 (for a strong base). The presence and concentration of many dissolved chemical constituents found in water are, in part, influenced by the hydrogen-ion activity of water. Biological processes including growth, distribution of organisms, and toxicity of the water to organisms are also influenced, in part, by the hydrogen-ion activity of water.

Phagotroph — An organism that obtains nutrients through the ingestion of solid organic matter. This class of organism includes all animals from the simplest, single-celled animal (for example, the protozoa) to the higher life forms. Organisms have some type of device to ingest particles, a digestive system, and a system to discard waste products. Contrast with *Osmotroph*.

Pharmacokinetics — The dynamic behavior of chemicals inside biological systems; it includes the processes of uptake, distribution, metabolism, and excretion.

Phase — (Chemistry) Any of the forms or states, solid, liquid, gas, or *Plasma*, in which matter can exist, depending on temperature and pressure; a discrete homogeneous part of a material system that is mechanically separable from the rest, as is ice from water.

Phase Rule — (Physics) A rule stating that the number of degrees of freedom in a material system at equilibrium is equal to the number of *Components* minus the number of *Phases* plus the constant 2. For example, the system of water vapor, liquid water, and solid ice has zero degrees of freedom because the three phases of vapor, liquid, and solid coexist in one component, water. A solution of salt in water, for example, is a chemical system in which the components are salt and water. The chemical components of a system can exist as gas, liquid, or solid phases. The phase rule is applicable only to systems, called heterogeneous systems, in which two or more physically distinct phases are in equilibrium. A system cannot contain more than one gas phase but can contain any number of liquid and solid phases. A water solution of salt contains three phases: Salt comprises the solid phase, water comprises the liquid phase, and water vapor formed by evaporation of the water comprises the gas phase. Water is an example of a heterogeneous chemical system of one component. The liquid and gas phases, water and water vapor, coexist over a wide range of temperatures and pressures. At one temperature and pressure, called the *Triple Point*, all three phases of water (liquid), water vapor (gas), and ice (solid) coexist at equilibrium. The phase rule is expressed by the equation $F = C - P + 2$, where “F” is the number of variables (usually temperature, pressure, and concentration) that can be

changed without causing the disappearance of a phase or the appearance of a new one. “C” represents the number of chemical components of the system and “P” the number of phases present.

Phenology — The science of appearances through and attempt to understand nature’s “clocks and calendars.” Today, it has taken on a meaning that links biological events and seasonal weather changes. These events include the hibernation of animals, the sprouting and flowering of plants, changing of leaf color, and the migration of birds.

Phenolic Compounds — Organic compounds that are derivatives of benzene.

Phenols — A group of organic compounds that in very low concentrations produce a taste and odor problem in water and which in higher concentrations are toxic to aquatic life. They are byproducts of petroleum refining, tanning, and textile, dye, and resin manufacturing processes.

Phenolphthalein Alkalinity — The alkalinity in a water sample measured by the amount of standard acid required to lower the pH to a level of 8.3, as indicated by the change in color of phenolphthalein from pink to clear. Phenolphthalein alkalinity is expressed as milligrams per liter of equivalent calcium carbonate. (2) A measure of the hydroxide ions plus one half of the normal carbonate ions in aqueous suspension. Measured by the amount of sulfuric acid required to lower the water to a pH value of 8.3, as indicated by a change in color of phenolphthalein. It is expressed as milligrams per liter of equivalent calcium carbonate.

Phosphates — General term used to describe phosphorus-containing derivatives of phosphoric acid (H_3PO_4). The chemical containing the phosphate group (PO_4^{-3}) can be either organic or inorganic and either particulate or dissolved. Phosphates constitute and important plant nutrient. Also see *Carlson’s Trophic State Index (TSI)*, *Total Inorganic Nitrogen (TIN)*, and *Total Inorganic Phosphate (TIP)*.

Phosphoric Acid — A term applied to any of three oxygen acids of phosphorus known respectively as ordinary or orthophosphoric, pyrophosphoric, and metaphosphoric acids. The most common form, orthophosphoric acid, or simply phosphoric acid, H_3PO_4 , is a syrup-like compound and an important ingredient in fertilizers. However, to be available for use by plants, the phosphates must be soluble in water or plant juices. Insoluble normal phosphates, as mineral phosphates, are therefore often converted into soluble acid salts by treatment with sulfuric acid. Phosphoric acid, when used as a fertilizer ingredient, is often blamed for excessive algae growth and oxygen losses in rivers and is frequently a leading toxin to aquatic life.

Phosphorus — (1) An element that is essential to plant life but contributes to an increased trophic level (*Eutrophication*) of water bodies. (2) One of the three primary nutrients in a complete fertilizer and the second one listed in the formulation on a fertilizer label: 10-8-6 (nitrogen, phosphorus, potassium). Also see *Phosphates* and *Phosphoric Acid*.

Phosphorus-Nitrogen Ratio — (Oceanography) The almost constant ratio of phosphorus to nitrogen in seawater and in plankton, by weight about 7:1 and by atom about 15:1.

Photic — (1) Penetrated by or receiving light. (2) Designating or relating to the layer of a body of water that is penetrated by sufficient sunlight for *Photosynthesis*. Also see *Photic Zone*.

Photic Zone — (Ecology) (1) The region of an aquatic system in which there is enough sunlight for photosynthesis to occur. (2) The upper water layer down to the depth of effective light penetration where *Photosynthesis* balances respiration. This level (the *Compensation Level*) usually occurs at the depth of 1 percent light penetration (i.e., 1 percent of surface light intensity) and forms the lower boundary of the *Zone of Net Metabolic Production*. Also see *Metabolism*.

Photoautotroph — An organism which utilizes carbon dioxide (CO_2) for cell growth and obtains its energy from the sun.

Photolysis — (1) A process in which organisms, with the aid of chlorophyll (green plant enzyme), convert carbon dioxide, CO_2 , and inorganic substances into oxygen, O_2 , and additional plant material, using sunlight for energy. All green plants grow by this process. (2) The breakdown of a material by sunlight. For example, nitrogen dioxide (NO_2) is split into nitric oxide (NO) and atomic oxygen (O) by the ultraviolet energy in sunlight. Photolysis is also an important degradation mechanism for contaminants in surface water and in the terrestrial environment.

Photolysis (of Water) — The lysis of water to give oxygen and hydrogen under the influence of light. This process is the source of the free oxygen formed in photosynthesis.

Photosynthesis — The process in green plants and certain other organisms by which carbohydrates are synthesized from carbon dioxide and water using light as an energy source. Most forms of photosynthesis release oxygen as a byproduct. Chlorophyll typically acts as the catalyst in this process.

Phreatic — (1) Of or relating to *Groundwater*. (2) (Volcanology) Of or relating to the explosion or eruption of nonincandescent material, such as steam or mud, from a volcano.

Phreatic Cycle — The time period during which the *Water Table* rises and falls. Also referred to as *Cycle of Fluctuation*.

Phreatic Explosion — A volcanic explosion caused by the conversion of groundwater to steam.

Phreatic Line — The line marking the upper surface of the *Zone of Saturation* in the soil.

Phreatic Surface — A term equivalent to the *Groundwater Surface* or the *Water Table*; the free surface of groundwater at atmospheric pressure.

Phreatic Water — Synonymous with the *Zone of Saturation*. A former term for water occurring in the upper part of the *Zone of Saturation*. Now generally replaced with the term *Groundwater*.

Phreatic Zone — A zone of *Groundwater* saturation. See *Zone of Saturation*.

Phreato-Magmatic — A magma being in contact with groundwater which is converted to the vapor phase.

Phreatophyte — (1) Literally, a water-loving plant, one that thrives in wet sites and/or has the ability to tap deep saturation zones. (2) A deep rooted plant that obtains its water from the water table. (3) A plant that habitually obtains its water supply from the *Zone of Saturation*, either directly or through the *Capillary Fringe*. (4) Plants which are heavy consumers of water, particularly those of arid or semi-arid regions. Phreatophytes send their roots to the water table, and typically are found on the shores of water bodies or along steam beds.

PHS — Public Health Service.

Phycology — The study of algae.

Phylogeny — The development or evolution of a kind or type of animal or plant.

Physical-Chemical Treatment Processes — A means of wastewater treatment using both physical and chemical processes.

Physical Landscape — Natural land forms and associated natural phenomena of a region.

Physical Oceanography — (Oceanography) The study of the physical characteristics and movements of the ocean, and the relationships between these factors, the atmosphere, and the sea floor.

Physical Waste Treatment Process — (Wastewater Treatment) Physical waste treatment processes include use of racks, screens, comminutors, clarifiers (sedimentation and flotation) and filtration. Chemical or biological reactions are important treatment processes, but not part of a physical treatment process.

Physical Weathering — The breaking down of parent rock into bits and pieces by exposure to temperature changes and the physical action of moving ice and water, growing roots, and human activities such as farming and construction. Compare to Chemical Weathering.

Physiographic Divisions — (Geography) Broad land groupings based on the physical features of the landscape.

Physiographic Province — (1) (Geography) A region of similar structure and climate that has had a unified *Geomorphic* history.

(2) (Geology) A region whose parts exhibit similar geologic structures and climate, and whose pattern of topographic relief differs significantly from that of adjacent regions, indicating a unified geomorphic history.

Physiography — (1) Description of nature or natural phenomenon in general; physical geography. (2) A description of the natural features of the surface of the earth.

Phytal Zone — (Ecology) The region of a shallow lake in which rooted vegetation grows.

Phytoaccumulation — See *Phytoextraction* and *Phytoremediation*.

Phytodegradation — See *Phytoremediation*.

Phytoextraction — (1) Also called *Phytoaccumulation*, refers to the uptake and translocation of metal contaminants in the soil by plant roots into the aboveground portions of the plants. Certain plants, called *Hyperaccumulators*, absorb unusually large amounts of metals in comparison to other plants. One or a combination of these plants is selected and planted at a site based on the type of metals present and other site conditions. After the plants have been allowed to grow for several weeks or months, they are harvested and either incinerated or composted to recycle the metals. This procedure may be repeated as necessary to bring soil contaminant levels down to allowable limits. If plants are incinerated, the ash must be disposed of in a hazardous waste landfill, but the volume of ash will be less than 10 percent of the volume that would be created if the contaminated soil itself were dug up for treatment. (2) A *Phytoremediation* process that represents the use of plants to remove heavy metals from soils, generally requiring the translocation of heavy metals to the easily harvestable shoots. Several cultivars of Indian mustard (*Brassica juncea*) have been investigated for their ability to efficiently accumulate lead and other heavy metals. The *Brassica* species included *B. nigra*, *B. oleracea*, *B. campestris*, *B. carinata*, *B. juncea*, and *B. napus*. Test results have indicated that *B. juncea* and *B. nigra* had the highest metal-accumulating ability among the species tested. Shoot growth was only slightly affected by exposure to lead over the concentration range tested. For the other metals examined, chromium had the highest phytoextraction coefficient, followed by cadmium, nickel, zinc, and copper.

Phytometer — A device for controlling the input of water to a plant, usually simply a sealed pot, that can be weighed so as to evaluate water use and growth.

Phytoplankton — (Ecology) (1) Small, usually microscopic plants (such as algae), found in lakes, reservoirs, and other bodies of water. (2) A type of plant plankton, such as algae, that is the basic food source in many aquatic and marine ecosystems. (3) Microscopic floating plants, mainly algae, that live suspended in bodies of water and that drift about because they cannot move by themselves or because they are too small or too weak to swim effectively against a current.

Phytoplankton Die-Off — (Ecology) An abrupt, massive mortality of *Phytoplankton* resulting from natural or manmade causes.

Phytoremediation — (1) A general term describing several ways in which plants are used to remediate contaminated sites by removing pollutants from soil and water. Through this process, certain adaptable plant species can be used to degrade organic pollutants or contain and stabilize metal contaminants by acting as filters or traps. (2) The use of green plants for low-cost, low-tech remediation processes in which selected plants and natural or engineered microorganisms work together to metabolize, convert, absorb, accumulate, sequester, or otherwise render harmless multiple environmental contaminants. There is scientific evidence that plants can degrade a portion of many organic contaminants and form less volatile compounds which are sequestered in the plant tissue. The remainder of the contaminant is passed out of the leaf tissue with the transpiration stream. Hybrid poplar plants fed by TCE- and PCE-spiked nutrient solutions in a greenhouse showed elevated degradation product levels in the leaves within a week, as well as evidence for transpiration of the TCE and PCE. (3) The use of selected crop plants or trees to extract or promote degradation of toxic substances in soils, groundwater, surface water, wastewater, and sediments. It may be possible in some cases to harvest such contaminants as heavy metals that have been taken up by plants and recover them for recycling. In other variations of this process, plants stimulate the growth of naturally-occurring microbial populations, which then degrade organic contaminants, such as petroleum hydrocarbons, in soils. At appropriate sites, the cost of applying phytoremediation techniques may range from half to less than 20 percent of the cost of using more traditional physical, chemical, or thermal techniques. Phytoremediation represents a small but growing subset of *in situ* remediation technologies for contaminated soil. Plants can be effective remediators by reaching contaminants through their root systems, their ability to accumulate metals and degrade organic compounds, and their reduced cost compared with other approaches. However, only those plants having the appropriate biochemical pathways, especially those that are able to survive in contaminated soil and water, are effective for soil cleanup. (4) An emerging cleanup technology for contaminated soils, groundwater, and wastewater that is both low-tech and low-cost, is defined as the engineered use of green plants to remove, contain, or render harmless such environmental contaminants

as heavy metals, trace elements, organic compounds, and radioactive compounds in soil or water. Current laboratory research has included a successful field demonstration of a plant bioreactor for processing the salty wastewater from petroleum wells and a greenhouse experiment on zinc uptake in hybrid poplar (*Populus* sp.). Because the roots sequester most of the contaminants taken up in most plants, a major objective of this program is to determine the feasibility of root harvesting as a method to maximize the removal of contaminants from soils. Available techniques and equipment for harvesting plant roots, including young tree roots, are being evaluated and modified as necessary for use. (5) An integrated approach to the cleanup of contaminated soils that combines the disciplines of plant physiology, soil chemistry, and soil microbiology. Removal of metals from contaminated soils using accumulator plants is the ultimate goal of the phytoremediation process. Particular emphasis has been placed on the remediation of heavy metals, such as chromium (Cr), lead (Pb), plutonium (Pu), and uranium (U). With the exception of Cr, these metals and their decay products exhibit two problems: (a) radiation dose hazards and their (b) chemical toxicity. Also, radiation dose hazards introduce the need for special precautions in reclamation beyond that associated with non-radioactive metals. The uptake of metals by plants occurs predominantly by way of channels, pores, and transporters in the root plasma membrane. Most vascular plants naturally absorb toxic and heavy metals through their roots to varying degrees. (6) An *in situ* remediation process that uses plants to cleanup contaminated soil and groundwater, taking advantage of plants' natural abilities to take up, accumulate, and/or degrade constituents of their soil and water environments. Research has shown this process to be applicable to a broad range of contaminants including numerous metals, radionuclides, and various organic compounds (such as chlorinated solvents, BTEX, PCBs, PAHs, pesticides/insecticides, explosives, nutrients, and surfactants). According to information reviewed, general site conditions best suited for use of phytoremediation include large areas of low to moderate surface soil (0 to 3 feet deep) contamination or large volumes of water with low-level contamination subject to low (stringent) treatment standards. Major advantages reported for phytoremediation as compared to traditional remediation technologies include the possibility of generating less secondary wastes, minimal associated environmental disturbance, and the ability to leave soils in place (*in situ*) and in a usable condition following treatment. Cited disadvantages include the long lengths of time required for this process (usually several growing seasons), depth limitations (3 feet for soil and 10 feet for groundwater), and the possibility of contaminant entrance into the food chain through animal consumption of plant material. Some of the specific methods that are being tested are described below:

- [1] **Phytoextraction** – Also called *Phytoaccumulation*, refers to the uptake and translocation of metal contaminants in the soil by plant roots into the aboveground portions of the plants. Certain plants, called *Hyperaccumulators*, absorb unusually large amounts of metals in comparison to other plants. One or a combination of these plants is selected and planted at a site based on the type of metals present and other site conditions. After the plants have been allowed to grow for several weeks or months, they are harvested and either incinerated or composted to recycle the metals. This procedure may be repeated as necessary to bring soil contaminant levels down to allowable limits. If plants are incinerated, the ash must be disposed of in a hazardous waste landfill, but the volume of ash will be less than 10 percent of the volume that would be created if the contaminated soil itself were dug up for treatment.
- [2] **Rhizofiltration** – Rhizofiltration is the adsorption or precipitation onto plant roots or absorption into the roots of contaminants that are in solution surrounding the root zone. The plants to be used for cleanup are raised in greenhouses with their roots in water rather than in soil. To acclimate the plants once a large root system has been developed, contaminated water is collected from a waste site and brought to the plants where it is substituted for their water source. The plants are then planted in the contaminated area where the roots take up the water and the contaminants along with it. As the roots become saturated with contaminants, they are harvested and either incinerated or composted to recycle the contaminants.
- [3] **Phytostabilization** – Phytostabilization is the use of certain plant species to immobilize contaminants in the soil and groundwater through absorption and accumulation by roots, adsorption onto roots, or precipitation within the root zone. This process reduces the mobility of the contaminant and prevents migration to the groundwater or air, and it reduces bioavailability for entry into the food chain. This technique can be used to reestablish a vegetative cover at sites where natural vegetation is lacking due to high metal concentrations in surface soils or physical disturbances to surficial materials. Metal-tolerant species can be used to restore vegetation to the sites, thereby decreasing the potential migration of contamination through wind erosion, transport of exposed surface soils, and leaching of soil contamination to groundwater.
- [4] **Phytodegradation** – Phytodegradation, also called *Phytotransformation*, is the breakdown of contaminants taken up by plants through metabolic processes within the plant, or the breakdown of contaminants external to the plant through the effect of compounds (such as enzymes) produced by the plants. Pollutants are degraded, incorporated into the plant tissues, and used as nutrients.
- [5] **Rhizodegradation** – Rhizodegradation, also referred to as *Enhanced Rhizosphere Biodegradation*, *Phytostimulation*, or *Plant-Assisted Bioremediation/Biodegradation*, is the breakdown of contaminants in the soil through microbial activity that is enhanced by the presence of the *Rhizosphere* and is a much slower process than phytodegradation. Microorganisms (yeast, fungi, or bacteria) consume and digest organic substances for nutrition and energy. Certain microorganisms can digest organic substances such as fuels or solvents that are hazardous to humans and break them down into harmless products through biodegradation. Natural substances released by the plant roots – sugars, alcohols, and acids – contain organic carbon that provides food for soil microorganisms, and the additional nutrients enhance their activity. Biodegradation is also aided by the way plants loosen the soil and transport water to the area.
- [6] **Phytovolatilization** – Phytovolatilization is the uptake and transpiration of a contaminant by a plant, with release of the contaminant, or a modified form of the contaminant, to the atmosphere from the plant (Transpiration). Phytovolatilization occurs as growing trees and other plants take up water and the organic contaminants. Some of

these contaminants can pass through the plants to the leaves and volatilize into the atmosphere at comparatively low concentrations.

Phytostabilization — See *Phytoremediation*.

Phytestimulation — See *Phytoremediation* and *Rizodegradation*.

Phytotoxicant — A chemical that can damage or kill plants in aquatic environments.

Phytotoxicity — The ability of chemicals to damage or kill plants in aquatic environments.

Phytovolatilization — See *Phytoremediation*.

Pickle Liquor — Acid solution used in the de-oxidizing of steel, used prior to galvanizing or other surface treatment to, say, prevent corrosion from water. Waste pickle liquor contains a portion of the original sulfuric acid and dissolved iron sulfate.

Pico — A prefix used in the metric system and other scientific systems of measurement which means 10^{-12} or 0.000000000001.

Picocurie (PC, pCi) — A picocurie is a unit of radioactivity. “Pico” is a metric prefix that means one one-millionth of one one-millionth, or 10^{-12} . A picocurie is one one-millionth of one one-millionth of a Curie. A Curie is that quantity of any radioactive substance that undergoes 37 billion nuclear disintegrations per second. Thus, a picocurie is that quantity of any radioactive substance that undergoes 0.037 nuclear disintegrations per second or 2.2 disintegrations per minute (dpm).

Picoplankton — (Ecology) Plankton in the size range 0.2-2.0 micrometers (um).

Piedmont — (1) An area, plain, slope, glacier, or other feature at the base of a mountain, for example, a foothill or a *Bajada*. In the United States, the Piedmont (region) is a plateau extending from New Jersey to Alabama and lying east of the Appalachian Mountains. (2) Lying or formed at the base of a mountain or mountain range; for example, a piedmont terrace or a piedmont pediment.

Piedmont Glacier — A thick sheet of ice formed at the base of a mountain range by the spreading out and joining of ice streams from higher elevations.

Piedmont Lake — A body of water that occupies a basin hollowed out by a *Piedmont Glacier*.

Piedmont Slope — A major physiographic part of an *Intermontane Basin* that comprises all of the constructional and erosional, major and component landforms from the basin floor to the mountain front and on into alluvium-filled mountain valleys.

Pier — (1) A structure or platform which extends from the shore out into a body of water, supported by piles or pillars, and serves primarily for mooring and landing ships or boats. (2) A structure (as a breakwater) extending into navigable water for use as a landing place or promenade or to protect or form a harbor. Frequently used synonymously with *Jetty*.

Piezometer — (1) An instrument used to measure *Pressure Head* in a conduit, tank, soil, etc. It usually consists of a small pipe or tube tapped into the side of the container, so that the inside end is flush with, and normal to, the water face of the container and is connected with a manometer pressure gage, mercury or water column, or other device for indicating pressure head. (2) An instrument for measuring pore water pressure within soil, rock, or concrete. (3) Also, an instrument for measuring the compressibility of liquids.

Piezometer (Open Well) — A well structure or tube which allows the level of saturation within a dam to be measured.

Piezometric — Refers to the surface to which the water from a given aquifer will rise under its full head.

Piezometric Head — Synonymous with *Hydraulic Head*, which is now commonly used.

Piezometric Surface — An imaginary surface that everywhere coincides with the static level of the water in the aquifer. This term is now generally considered to be obsolete, being replaced by the term *Potentiometric Surface*.

Piezometry — (Physics) The measurement of the compressibility of liquids.

Pingo — An Arctic mound or conical hill, consisting of an outer layer of soil covering a core of solid ice.

Pillow — In a river course, the layer of slack water that pads the upstream face of rocks and other obstructions. The broader the upstream face, the more ample the pillow. Also called an *Eddy Cushion*.

Pingo — In an arctic *Permafrost* region, a small hill or large cone-shaped mound of soil-covered ice that is a localized upwarp of the land surface caused by the hydrostatic pressure of *Groundwater*.

Pingo Ice — Relatively clear ice occurring in a *Permafrost* region.

Pink Snow — See *Red Snow*.

Pinnate Drainage Pattern — A pattern of natural stream courses in which the main stream is joined at acute angles by many closely spaced sub-parallel tributaries.

Pioneer Plants — *Herbaceous* annual and seedling perennial plants that colonize bare areas as a first stage in secondary succession.

Pipeline — A conduit of pipe, especially one used for the conveyance of water, gas, or petroleum products.

Piping — (1) The progressive development of erosion of a dam structure by seepage, appearing downstream of the dam as a hole or seam discharging water that contains soil particles. (2) The process by which water forces an opening around or through a supposedly sealed structure, such as a check dam or levee. As water flows through, the opening usually grows larger and the water carries away sediment or levee material. Also referred to as *Internal Erosion*. (3) Subsurface erosion by *Percolation* that results in the caving in and forming of narrow tunnels or pipes through which soluble or granular materials are removed from the soil. Also referred to as *Tunnel Erosion*. (4) An arrangement of pipes set up to convey fluid.

Pirate Stream — One of two streams in adjacent valleys that has been able to deepen its valley more rapidly than the other, has extended its valley headward until it has breached the divide between them, and has captured the upper portion of the neighboring stream.

Pitch — In a river system, a section of a rapid steeper than the surrounding portions; a drop.

Pitless Unit or Pitless Adaptor — A unit or adapter designed to permit water service pipes to pass through the wall of the well casing below the frostline, to prevent entrance of contaminants, and to provide full access to the water system components within the well.

Pitot Tube — An instrument used to measure the velocity of flowing water, with the velocity head of the stream an index of velocity. It consists essentially of an orifice held to a point upstream in the water, connected with a tube in which the rise of water due to velocity head may be observed and measured. It also may be constructed with an upstream and downstream orifice, with two water columns, in which case the difference in height of the water columns in the tubes is the index of velocity.

Pitting — The construction of pits or basins of suitable capacity and distribution to retain water and increase infiltration on rangeland.

PL (P.L.) — Public Law.

Place of Use — The specific location, typically documented in a water right permit, where water is applied or used. A water user cannot use water at another location without transferring the right or obtaining a new right.

Place of Use Limitation — In the context of water law, the act of defining a water right so that the owner of the right may not freely change the place of use without consideration of the effect of such change on other water users.

Placer — (Geology) (1) A glacial or alluvial deposit of heavy minerals such as gold or platinum concentrated in stream or beach gravels. (2) A place where a placer deposit is washed to extract its mineral content.

Plain — (1) Level or gently rolling land, usually below 2,000 feet (610 meters) in elevation. (2) A flat, undulating, or even rolling area, larger or smaller, that includes few prominent hills or valleys, that usually is at low elevation in reference to surrounding areas, and that may have considerable overall slope and local relief.

Plain Tract — The lower section of a stream, having a low gradient and a wide *Floodplain*.

Plan — A compilation of goals and objectives, policy statements, and implementation strategies for guiding the physical, social, and/or economic development of an area or region; may be comprehensive or may relate to a specific resource, i.e., a *Water Resource Plan* which assesses both sources and use of water and develops strategies for their most effective and efficient use.

Planation Stream Piracy — The diversion of water from the upper part of a smaller stream to the channel of a larger *Meandering Stream*. Typically this results from a leveling of the inter-stream area by the lateral erosion of the meandering stream.

Plane — To skim across the surface of the water.

Plane Jet — A flow pattern in which the water flowing into another body of water spreads out in the shape of a parabola whose dimensions are related to the distance downstream from the mouth.

Plankton — (1) Small, usually microscopic, plants (*Phytoplankton*) and animals (*Zooplankton*) in aquatic systems. The passively floating or weakly swimming plant and animal life present within a body of fresh or salt water. (2) All of the smaller floating, suspended or self-propelled organisms in a body of water. (3) Minute floating forms of microscopic plants and animals in water which cannot get about to any extent under their own power. (4) The community of suspended, floating, or weakly swimming organisms that live in the open water of lakes and rivers. They form the important beginnings of food chains for larger animals. Concentrations are expressed as a number of cells per milliliter (cells/mL of sample).

Plankton Bloom — A large quantity of plankton giving water a definite color. Pond water usually appears green because the majority of plankton organisms are greenish, but plankton blooms may also appear black, yellow, red, brown, or blue-green.

Planning — A comprehensive study of present trends and of probable future developments, together with recommendations of policies to be pursued. Planning embraces such subjects as population growth and distribution; social forces; availability of land, water, minerals, and other natural resources; technological progress; and probable future revenues, expenditures, and financial policies. Planning must be responsive to rapidly changing conditions.

Planning Horizon — The overall time period considered in the planning process that spans all activities covered in or associated with the analysis or plan and all future conditions and effects or proposed actions which would influence the planning decisions.

Plant-Assisted Bioremediation — See *Phytoremediation* and *Rhizodegradation*.

Plant Community — (Biology) An assemblage of plants characterized or dominated by certain species.

Plant Community Diversity — (Biodiversity Measure) Diversity (richness and evenness) or riparian plant communities by type (forest, wet meadow, dry meadow, shrub). This measure provides an index of diversity at the community/ecosystem scale of the biological dimension.

Plant Nutrients — The primary mineral ingredients of fertilizer: phosphate (PO_4^{-3}), nitrate (NO_3^{-}), and ammonium (NH_4^{+}), together with an extensive array of chemical elements (*Trace Elements*) used in lesser amounts to support the growth of plants.

Plash — (1) To cause a splashing or spattering effect. (2) To break the surface of the water; to splash. (3) A puddle, pool, or small pond of standing water that forms after a flood or heavy rain, or from melting snow.

Plasma — (Physics) An electrically neutral, highly ionized gas composed of ions, electrons, neutral particles. It is a *Phase* of matter distinct from solids, liquids, and normal gases.

Plasmolysis — Shrinkage or contraction of the protoplasm away from the wall of a living plant or bacterial cell, caused by loss of water through *Osmosis*.

Plastic Flow — A continuous and permanent change of shape in any direction without breakage.

Plastic Soil — A soil capable of being molded or deformed continuously and permanently, by relatively moderate pressure into various shapes.

Plate Crystal — An ice crystal that exhibits typical hexagonal symmetry, but has relatively little thickness parallel to its principal axis.

Plate Boundaries — (Geology) According to the theory of *Plate Tectonics*, the locations where the rigid plates that comprise the crust of the earth meet. The plates move slowly on the molten material beneath in the process called *Continental Drift*. As the plates meet, the boundaries can be classified as divergent (places where the plates are moving apart, as at the mid-ocean ridges of the Atlantic Ocean), convergent (places where the plates are colliding, as at the Himalayas Mountains), and transform (places where the plates are sliding past each other, as the San Andreas fault in California).

Plate Tectonics — (Geology) (1) A theory of global tectonics in which the *Lithosphere* is divided into a number of plates whose

pattern of horizontal movement is that of torsionally rigid bodies that interact with one another at their boundaries, causing seismic and tectonic activity along these boundaries. (2) The concept that both continents and ocean basin are only the emergent parts of large pieces or plates of the earth's surface. It is generally agreed that the global surface can be divided into at least twenty discrete plates (seven major and many minor) with each plate moving in a different direction from that of its neighbor. It is this motion that creates the variety of features of the earth as well as leads to instability along the plate edges. The motion of the plates is believed to be caused by tremendous heat and pressure built up beneath the relatively thin veneer of the overlying plates. The motion of the plates is characterized by spreading centers whereby molten rock is forced to the surface to form new crustal rocks, and collision zones where plates meet and the older, heavier plate is forced beneath the newer, lighter plate to be turned into a molten state once again deep beneath the earth's surface. This subduction process builds up the mountains along the collision line and results in considerable seismic activity. The seven major plates are named for the continents or oceans and include Pacific, Eurasian, African, Australian, North American, South American, and Antarctic. Also see *Plate Boundaries*.

Plateau — (Geology) A level, elevated land area, usually between 2,000 and 6,000 feet (610–1,830 meters) in elevation.

Plateau Basalts — A term applied to widespread nearly horizontal layers of extrusive basalt.

Plateau Glacier — A *Glacier* formed on a mountain plateau, usually overflowing the edges in hanging glaciers.

Platelet — One of the small ice crystals that join together to form a layer of floating ice and serve as seed crystals for the further thickening of the ice cover.

Playa — (1) Generally, a dry or intermittently dry lakebed in the lowest spot of a closed valley. A dry bed of an ephemeral shallow lake in a nearly level area on the floor of a desert basin. (2) An ephemerally flooded, barren area on a basin floor that is veneered with fine textured sediment and acts as a temporary or the final sink for drainage water. (3) The surfaces at lowest elevation within a basin of interior drainage in arid regions. After heavy rainfall or flash floods these areas temporarily may become inundated, becoming shallow, muddy lakes but drying out again in the absence of further water flow. (4) Also, a nearly level area at the bottom of an undrained desert basin, sometimes temporarily covered with water. Salt contents are generally quite high. The term *Playa* is interchangeable with the term *Sink*. (Geology) (5) In an arid or semiarid region, a low, flat, dried up, barren area at the bottom of a closed lake basin from which rainwater quickly evaporates, often leaving behind deposits of salt. (6) A small, sandy area at the mouth of a stream or along the shore of a bay. (7) A flat, alluvial area along a coast, as distinguished from a beach.

Playa Lake — (1) A temporary lake formed in a *Playa*. A shallow, intermittent lake in an arid region, occupying a playa in the wet season but drying up in the summer; an ephemeral lake that upon evaporation leaves or forms a playa. (2) Typically existing in an arid or semiarid region, a shallow lake that temporarily covers or fills a *Playa* during the wet season, or a temporary lake that leaves or forms a playa upon evaporation.

Pleistocene — (Geology) Of, belonging to, or designating the geologic time, rock series, and sedimentary deposits of the earlier of the two epochs of the Quaternary Period. This epoch was characterized by the alternate appearance and recession of northern glaciation and the appearance of the progenitors of human beings. Also commonly referred to as the *Ice Age*, the Pleistocene covered a period of time from about 2 million years ago to 10,000 years ago and immediately preceded the Holocene Epoch, or the period from 10,000 years ago to the present. The late Pleistocene is generally considered to be the Wisconsin Age (North America), which extended from about 300,000 years ago to 10,000 years ago and the beginning of the Holocene.

Pleuston — (1) Plants that float on the surface of bodies of fresh water. (2) Organisms living in the thin surface layer existing at the air-water interface of a body of fresh water.

Plimsoll's Mark — (Nautical) The load-line mark conspicuously painted originally on the sides of all British merchant vessels and used to indicate the limit of submergence allowed by law. A similar mark has been required since 1930 on all ships registered in the United States.

Pliocene — (Geology) The epoch immediately preceding the *Pleistocene* which lasted for about 10 million years' duration from about 12 million years ago to about 2 millions years ago.

Plop — To fall with a sound like that of an object falling into water without splashing.

Plow (or Plough) — To cleave the surface of or move through water.

Plowshare — A wedge-shaped feature that develops on the surface of snow as a result of further *Ablation* of foam crust.

Plug — (1) The procedure by which a well is sealed after it has been abandoned. (2) Cement, grout, or other material used to fill and seal a hole drilled for a water well.

Plug Flow — A type of flow that occurs in tanks, basins, or reactors when a slug of water moves through without ever dispersing or mixing with the rest of the water flowing through.

Plugging — The act or process of stopping the flow of water, oil, or gas into or out of a formation through a borehole or well penetrating that formation.

Plumb — A weight on the end of a line, used to determine water depth.

Plumber — One who installs, repairs, and maintains piping, fittings, and fixtures involved in the distribution and use of water in a building.

Plumbing — The pipes, fixtures, and other apparatus of a water, gas, or sewage system in a building.

Plume — (1) (Ecology) A space in air, water, or soil containing pollutants released from a point source. (2) (Water Pollution) The way polluted water extends downstream from the pollution source (analogous to smoke from a smoke-stack as it drifts downwind in the atmosphere). (3) A relatively concentrated mass of emitted chemical contaminants spreading in the environment. In surface water, the effluent added to a receiving stream near a point source. For example, when a heated-water discharge is added to a stream, the heated water does not mix immediately with the stream water. The mass of hot water remains detectable for some distance downstream. In groundwater, the *Leachate* leaking down-gradient from a site of buried waste material.

Plunge — To thrust or cast oneself into, or as if into, water.

Plunge Basin — A depression formed at the base of a cliff or waterfall that has been scoured out by falling water. Also referred to as a *Plunge Pool* if filled with water.

Plunge Point — (Oceanography) (1) The point at which a plunging wave curls over and falls. (2) The final point at which a wave may be said to break before it rushes up the beach.

Plunge Pool — (1) A *Plunge Basin*. (2) A deep, circular lake that occupies such a plunge basin after the stream has been diverted or the waterfall no longer exists. Also referred to as a *Waterfall Lake*.

Plutonic Water — Water contained in or derived from magma at considerable depths.

Pluvial — (1) (Meteorology) Of or relating to precipitation, particularly an abundant amount. Of having to do with rain; rainy. (2) To flow, pour, or fill. (3) (Ecology) Describing a time period or climate characterized by heavy rainfall. (Geology) (4) Formed or caused by the action of rain, as a pluvial deposit. Describing an interval of geologic time characterized by a large amount of precipitation; usually applied to periods of heavy rainfall in the lower latitudes. Also, describing a geologic episode, process, deposit, or feature that results from or is affected by the action of rain, for example a *Pluvial Lake*. (5) More specifically, the two or more Wisconsin stages, of the late *Pleistocene* age (epoch), when the western United States waterbasins were filled with lakes. The *Early Pluvial* period consisted of periods of high humidity so remote as to have left no clear-cut shore features; the *Postpluvial* period represented a period of desiccation following the last high lake stage.

Pluvial Lake — A lake formed during a period of increased rainfall, particularly such a lake formed during the glacial advances in the *Pleistocene Epoch* that is now either extinct or exists as a remnant. Pluvial lakes have shown considerable fluctuations in water levels primarily due to extreme climatic changes and profound fluctuations in precipitation and evaporation rates. The Pleistocene Epoch, extending from 2 million years B.P. to about 10,000 years B.P. has been the only time period known to have had enough fluctuation in climatic patterns and precipitation and evaporation levels to produce pluvial lakes of any magnitude. Furthermore, pluvial lakes are formed within closed basin formations that have no through-drainage outlets into surrounding fluvial or coastal systems, i.e., they do not drain to the sea. Because of this restriction, ancient pluvial lakes of North America, most especially *Lake Bonneville* and *Lake Lahontan*, as well as their modern day remnants, such as the Great Salt Lake, Pyramid Lake, and Walker Lake, are mainly found in the arid and semi-arid regions, and mostly within the *Great Basin* area which covers most of Nevada and western Utah. The closed-system restriction is probably the most important factor for the formation of a pluvial lake, the second being a high ratio of precipitation to evaporation (i.e., a high “effective” moisture level). A closed system is interpreted as one which is almost entirely shut off from surrounding environments, therefore making it nearly self-contained. The Lahontan basin area, in which Lake Lahontan was formed, isn’t completely cut off from outside precipitation systems since precipitation from the west does make its way over the Sierra Nevada from time to time. However, these small amounts of precipitation have an overall very miniscule effect on the inner workings of the system itself. Lake Lahontan formed during a time period of heightened precipitation and decreased *Evapotranspiration*. Precipitation in the Lake Lahontan region today is thought to be about one tenth of what it was during the Pleistocene, and evapotranspiration is now much greater, therefore creating an inverse relationship between the two time periods. Also see *Geologic Time*.

Pluvial Period — A period of increased rainfall and decreased evaporation, which prevailed in nonglaciated areas during the time of ice advance elsewhere.

Pluviofluvial — Of or relating to a geologic process or feature that results from or is affected by the combined action of rainwater and streams.

Pluviometer — A *Rain Gauge*.

Pluvius — Characterized by heavy rainfall; rainy.

PMCL — See *Primary Maximum Contaminant Level*.

Pneumatic Ejector — A device for raising wastewater, sludge or other liquid by compressed air. The liquid is alternately admitted through an inward swinging check valve into the bottom of an airtight pot. When the pot is filled compressed air is applied to the top of the liquid. The compressed air forces the inlet valve closed and forces the liquid in the pot through an outward swinging check valve, thus emptying the pot.

Pocosin — An upland swamp of shallow water of the coastal plain of the Southeast United States; a “Dismal”, as used in the southern United States.

Podsolization — Process by which soils are depleted of bases, becoming acid, and develop eluvial A-horizons and illuvial B-horizons. A podsol develops with more rapid removal of iron and alumina than of silica.

POE — Point of entry for a water treatment device or system.

Pogonip — A term used in the Western United States denoting a dense winter fog containing frozen particles, formed in the deep valleys of the Sierra Nevada.

Point Bar — (1) A bank on the inside of a *Meander* bend that has built up due to sediment deposition opposite a pool. (2) (Geology) One of a series of low, curved ridges of sand and gravel enclosed by a growing meander and formed by the gradual addition of accretions as the channel migrates toward the outer bank. Also referred to as *Meander Bar*.

Point Discharge — The instantaneous rate of discharge, in contrast to the mean rate for an interval of time.

Point of Compliance (POC) — (Water Quality) For a hazardous waste treatment, storage, or disposal facility, the location, specified by the operations permit of the facility, for down-gradient wells. The wells are placed to detect the presence of any contaminants released from the facility into groundwater that will move into the uppermost aquifer in the area.

Point of Compliance [EPA] — For groundwater, it represents where a facility should monitor groundwater quality and/or achieve specified levels of groundwater quality to achieve facility-specific cleanup goals.

Point of Disinfectant Application — The point where disinfectant is applied and water downstream of that point is not subject to re-contamination by surface water runoff.

Point of Diversion — The point from which water is diverted from a source.

Point(s) of Diversion — Broadly, the point(s) specified in a water right permit from which water is diverted from a source. Also refers to a river, stream, canal, or reservoir where irrigation water is diverted into an irrigation project.

Point-of-Entry (POE) Treatment Device — (Water Quality) A treatment device applied to the drinking water entering a house or building to reduce the contaminants in the water distributed throughout the house or building.

Point-of-Use (POU) Treatment Device — (Water Quality) An approach to the management of the quality of drinking water that locates a water treatment device at the faucet in an individual household. Such devices are sometimes used in homes supplied by a private well that does not meet drinking water standards.

Point Pollution Source — See *Point Source (PS)*.

Point Precipitation — Precipitation at a particular site, in contrast to the mean precipitation over an area.

Point Source (PS) — (1) A stationary or clearly identifiable source of a large individual water or air pollution emission, generally of an industrial nature. (2) Any discernible, confined, or discrete conveyance from which pollutants are or may be discharged, including (but not limited to) pipes, ditches, channels, tunnels, conduits, wells, containers, rolling stock, concentrated animal feeding operations, or vessels. Point source is also legally and more precisely defined in federal regulations. Contrast with *Non-Point Source (NPS) Pollution*.

Point Source (PS) Pollution — (1) Pollution originating from any discrete source. (2) Pollutants discharged from any distinct, identifiable point or source, including pipes, ditches, channels, sewers, tunnels, wells, containers of various types, concentrated animal-feeding operations, or floating craft. Also referred to as *Point Source of Pollution*. Also see *Non-Point Source (NPS) Pollution*.

Point Waste Load Allocation — The amount of a particular pollutant a *Point Source*, e.g., a wastewater treatment facility, can discharge over a specified period of time into a receiving body of water. Allocations are a result of agreed upon water quality standards for a stream.

Poised Stream — A stream that neither deposits nor erodes sediment.

POL — Petroleum, oil, and lubricant.

Polar (Ice) Cap — (1) An ice sheet that is centered at one of the earth's poles. Either of the regions around the poles of the earth that are permanently covered with ice. (2) A high-altitude icecap. (3) (Astronomy) Seasonal or permanent deposits of snow, ice, or frozen material in the polar regions of another planet, for example, Mars. Either of the regions around the poles of Mars that are covered with frozen carbon dioxide (CO₂) and water.

Polar Firn — Firn that is formed at low temperatures where no liquid water is present and no melting takes place. Also referred to as *Dry Firn*.

Polar Glacier — A *Glacier* that has a subfreezing temperature throughout its mass and that experiences no melting even in summer.

Polar Lake — A lake whose surface temperature never rises above 4 degrees Centigrade.

Polder — An area of low-lying land, especially in the Netherlands, that has been reclaimed from a body of water and is protected by dikes.

Policy — (Water Planning) A statement of governmental intent against which individual actions and decisions are evaluated. The wording of policies conveys the level of commitment to action, for example, policies which use the word "shall" are mandatory directives, while those using the word "should" are statements of direction to be followed unless there are compelling reasons to do otherwise. Also see *Water Planning* and *Water Policy*.

Polishing — (Water Quality) The removal of low concentrations of dissolved, recalcitrant organic compounds from either water intended for human consumption or wastewater that has been subjected to *Primary* and *Secondary Wastewater Treatment*. The passage of water through a charcoal filtering device is a frequently employed polishing technique.

Pollutant — (1) Generally, any substance introduced into the environment that adversely affects the usefulness of a resource. (2) Something that pollutes, especially a waste material that contaminates air, soil, or water. (3) Any substance of such character and in such quantities that when it reaches a body of water, soil, or air, it is degrading in effect so as to impair their usefulness or render them offensive. (4) Any solute or cause of change in physical properties that renders water unfit for a given use. (5) Any substance which causes an impairment (reduction) of water quality to a degree that has an adverse effect on any beneficial use of the water. (6) Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal and agricultural waste discharged into water and onto the ground where subsurface waters can become contaminated by leaching. (Definition from Section 502(6) of the *Clean Water Act*.)

Pollutant Trading — An option developed by the *U.S. Environmental Protection Agency (EPA)* which allows communities to remove a non-point or other pollution source in lieu of building a more expensive wastewater treatment process in order to meet *Clean Water Act (CWA)* discharge standards. The reasoning behind this effort was primarily economic: it was generally cheaper to remove the non-point pollution source than build a more sophisticated and expensive wastewater facility.

Polluted — Something which contains foreign substances.

Pollution — (1) Harmful substances deposited in the air or water, or land, leading to a state of dirtiness, impurity, or unhealthiness. (2) Generally, the presence of matter or energy whose nature, location or quantity produces undesired environmental effects. (3) Any alteration in the character or quality of the environment which renders it unfit or less suited for certain uses. With respect to water, the alteration of the physical, chemical, or biological properties by the introduction of any substance that adversely affects any beneficial use. (4) The process of contaminating air, water, and land with impurities to a level that is undesirable and results in a decrease in usefulness of environment for beneficial purposes; adverse effects on the environment that are definitely man-produced. (5) The impairment (reduction) of water quality by agricultural, domestic or industrial wastes (including thermal and radioactive wastes) to a degree that the natural water quality is changed to hinder any beneficial use of the water or render it offensive to the senses of sight, taste, or smell or when sufficient amounts of wastes create or pose a potential threat to human

health or the environment. (6) Adverse and unreasonable impairment of the beneficial uses of water even though no actual health hazard is involved. Under the *Clean Water Act (CWA)*, for example, the term is defined as the manmade or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

Pollution Indicator Organism — (Water Quality) A plant or animal species that is not normally present in an aquatic environment unless the body of water has been subjected to damage by pollution. For example, *Escherichia coli* is a bacterium that is not found in the aquatic environment unless the system has been contaminated by the addition of fecal material. The organism signals the presence of pollution.

Pollution Source — Anything that causes surface water or groundwater pollution including but not limited to the following: (1) wastes, point source, and pollutants; (2) wastewater absorption, evapotranspiration, and graywater systems; (3) seepage pits, cesspools; (4) barnyards, barn gutters, feed lots, animal pens, and farm silos.

Polyacrylamides (PAMs) — (Water Quality) Synthetic polymers with extensive water-retention and water-saving capabilities used to halt erosion and promote dryland farming. The polymers used are long-lasting, gel-forming, water-absorbing materials that can absorb more than 400 times their weight in distilled or pure water. While commercial florists have used PAMs for a number of years, the polymers are now available on a commercial scale to where farmers can incorporate them into the soil like powdered fertilizers and pesticides. In addition to direct application to both soil and irrigation water, the polymers may also be woven into a fabric to cover the surface for weed control and additional moisture conservation.

Polychlorinated Biphenyls (PCBs) — (Water Quality) A group of synthetic, toxic industrial chemical compounds once used in making paint and electrical transformers which are chemically inert and not biodegradable. PCBs were frequently found in industrial wastes, and subsequently found their way into surface and groundwaters. As a result of their persistence, they tend to accumulate in the environment. In terms of streams and rivers, PCBs are drawn to sediment, to which they attach and can remain virtually indefinitely. Although virtually banned in 1979 with the passage of the Toxic Substances Control Act, they continue to appear in the flesh of fish and other animals.

Polychlorinated Naphthalenes (PCNs) — (Water Quality) Industrial chemicals that are mixtures of chlorinated naphthalene compounds. They have properties and applications similar to polychlorinated biphenyls (PCBs) and have been identified in commercial PCB preparations.

Polycyclic Aromatic Hydrocarbons/Polararomatic Hydrocarbons (PAHs) — (Water Quality) Polycyclic aromatic hydrocarbons, or PAHs, are a class of very stable organic molecules made up of only carbon and hydrogen. These molecules are flat, with each carbon having three neighboring atoms much like graphite. An example is the PAH coronene, with chemical symbol $C_{24}H_{12}$. These molecules are highly carcinogenic, but they are also very common. PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or even charbroiled meat (such as benzo[a]pyrene). PAHs are usually found as a mixture containing two or more of these compounds, such as soot. Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides. PAHs are also present in marine conditions where heavy motorboat traffic exists. Some characteristics of PAHs are shown below:

- [1] PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- [2] PAHs can occur in air attached to dust particles.
- [3] Some PAH particles can readily evaporate into the air from soil or surface waters.
- [4] PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days or weeks.
- [5] PAHs enter water through discharges from industrial and wastewater treatment plants or through marine engine exhaust releases.
- [6] Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- [7] Microorganisms can break down PAHs in soil or water after a period of weeks or months.
- [8] In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- [9] PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live, indicating a tendency towards *Bioaccumulation*.

Polyelectrolyte — (Water Quality and Wastewater Treatment) (1) A high molecular weight substance which results in charged ions upon dissolving in water. Organic polyelectrolytes, also referred to simply as *Polymers*, such as starches and gums, are widely used in the flocculation process and as coagulant aids in water and wastewater treatment. The three basic types of polymers for water clarification are *cationic*, *anionic*, and *non-ionic*. Cationic polymers can be used in place of, or as a supplement to, inorganics in primary coagulation. Anionic and non-ionic polymers have greater size and weight and are most effective as flocculants or coagulant aids. Anionic polymers are preferred for wastes containing inorganic solids, while cationics are better for treatment of oily water and biologically active sludges. (2) A high-molecular-weight (relatively heavy) substance having points of positive or negative electrical charges that is formed by either natural or man-made processes. Natural polyelectrolytes may be of biological origin or derived from starch products and cellulose derivatives. Man-made polyelectrolytes consist of simple substances that have been made into complex substances of high molecular weight. Used with other chemical coagulants to aid in binding small suspended particles to larger chemical flocs for their removal from water.

Polyhaline — Term to characterize water with salinity of 18 to 30‰ (parts per thousand), due to ocean salts.

Polynuclear Aromatic Hydrocarbons (PNAs) — A group of highly reactive organic compounds, such as naphthalene and biphenyls, that are a common component of creosotes, which can be carcinogenic.

Polynya — (Oceanography) A Russian word referring to a large expanse of water that is surrounded by ice; usually found near the

shore, often at the mouth of a large river.

Polysaline — Term to characterize water with salinity of 18 to 30‰ (parts per thousand), due to land-derived salts.

Polymer — (Water Quality) (1) A chemical formed by the union of many monomers (a molecule of low molecular weight). Polymers are used with other chemical coagulants to aid in binding small suspended particles to larger chemical flocs for their removal from water. All *Polyelectrolytes* are polymers, but not all polymers are polyelectrolytes. (2) A substance which consists of giant molecules formed by the linkage of simple molecules (monomers). The linkage process is a chemical reaction called polymerization. In the water and wastewater treatment process, polymers are also referred to as polyelectrolytes.

Polymictic Lake — A lake that has no lasting thermal *Stratification*.

Pond — A body of water smaller than a lake, often artificially formed.

Pond Scum — A mass of filamentous algae forming a green scum on the surface of ponds and other such bodies of water.

Pond, Wastewater Stabilization — (Water Quality) An impoundment area for water, natural or artificial, into which untreated or partially treated wastewater is discharged and in which natural purification and stabilization processes take place under the influence of sunlight, air, and biological activity. Also see *Lagoon*.

Pondage — (1) Water whose natural flow is regulated by holding it in a reservoir for short periods of time. (2) The holding back of water for later release for power development above the dam of a hydroelectric plant to: (a) equalize daily or weekly fluctuations of streamflow, or (b) to permit irregular hourly use of water by the wheels to take care of fluctuations in the load demand. (3) The water so held back and later released. (4) The storage capacity available for the use of such water.

Pondage Land — (Geology) The area of land where water is stored or held as dead water during flooding. Also referred to as *Flood Fringe*.

Ponded Stream — A stream in which a pond has formed because the normal streamflow has been interrupted.

Ponding — (1) The natural formation of a pond in a stream whose normal streamflow has been interrupted. (2) The artificial containment of water in a stream to form a pond. (3) (Building Engineering) The accumulation of rainwater on a flat roof because of poor drainage. (4) (Wastewater Treatment) A condition occurring on trickling filters when the hollow spaces (voids) become plugged to the extent that water passage through the filter is inadequate. Ponding may be the result of excessive slime growths, trash, or media breakdown.

Pool — (1) A small, still, deep reach of a stream. A deep and quiet stretch of river. (2) A location in an active stream channel, usually located on the outside bends of meanders, where the water is deepest and has reduced current velocities. (3) A small, natural body of standing water, usually fresh, generally regarded as smaller than a pond. (4) Any small collection of water on a surface, such as a rain puddle. (5) An artificially confined body of water above a dam or the closed gates of a lock. (6) A deep reach of a stream; a part of the stream with depth greater than the surrounding areas frequented by fish. The reach of a stream between two riffles; a small and relatively deep body of quiet water in a stream or river. Natural streams often consist of a succession of pools and riffles.

Pool-Riffle Ratio — The ratio of pool and riffle areas, or pool and riffle length in a given stream reach.

Pool Spring — A pool of water that is created and fed by an underground spring.

Popple — To move in a tossing, bubbling, or rippling manner, as choppy water.

Population — (1) (Ecology) The total of interbreeding organisms that represents a level of organization at which speciation occurs. (2) (Statistics) The total number of potential observations in a specific category, for example, the human population of a particular city, or the number of animals of a particular species within a defined area. Typically, measurements of the behavior and characteristics of the population are not possible and therefore a *Sample* is selected which, if an *Unbiased Sample*, will, even in its limited numbers, be representative of the characteristics of the total population.

Population at Risk — A population subgroup that is more likely to be exposed to a chemical, or is more sensitive to a chemical, than is the general population.

Population Density — (1) (Ecology) The number per unit area of individuals of any given species at a given time. (2) (Water Planning) The number of people in a given area. The number may be obtained by multiplying the number of dwelling units per unit area (e.g., square mile, square kilometer, acre, etc.) by the number of residents per dwelling unit.

Population Equivalent (PE) — (Wastewater Treatment) A way to express the strength of industrial waste in terms of the comparable amount of *Biochemical Oxygen Demand (BOD)* in the household wastewater produced by one person. An industrial waste that has a PE of 1,000 is equivalent to the BOD of waste produced by 1,000 people.

Population Equivalent (Hydraulic) — (Wastewater Treatment) A flow of 100 gallons per day is the hydraulic or flow equivalent to the contribution or flow from one person. Population equivalent = 100 *Gallons per Capita per Day (GPCD)*.

Population Parameter — (Statistics) A quantity or statistical measure which, for a given population, is fixed and which is used as the value of a variable in some general distribution or frequency function to make it descriptive of that population.

Population Pressure — (Ecology) The force exerted by a growing population upon its environment, resulting in dispersal or reduction of the population. Frequently used in the plural, i.e., population pressures, to denote a variety of effects on environmental and resource conditions.

Population Viability Analysis — (Ecology) Scientific methodology for identifying the size of a population of species necessary to sustain it.

Pore — Synonymous with *Interstice (Interstitial)*.

Pore Ice — Ice that more or less fills the pore spaces in the ground as a result of the freezing of interstitial water in place, with no additional water being present.

Pore Pressure — Pressure exerted by fluid in the void space of soil or rock; the interstitial (pore) movement of water that may take place through a dam, its foundation, or its abutments. Also see *Neutral Stress*.

Pore Space — That portion of rock or soil not occupied by solid mineral matter and which may be occupied by groundwater.

Pore Water — See *Interstitial Water*.

Pore-Water Pressure — See *Neutral Stress*.

Porosity — (1) Most generally, porosity is the property of containing openings or interstices. More specifically, the percentage of the bulk volume of a rock or soil that is occupied by interstices, whether isolated or connected. (2) The percentage of the bulk volume of a rock or soil that is occupied by interstices, whether isolated or connected. The proportion, usually stated as a percentage, of the total volume of a rock material or *Regolith* that consists of pore space or voids. (3) In rock or soil, it is the ratio (usually expressed as a percentage) of the volume of openings in the material to the bulk volume of the material. (4) With respect to water, porosity is a measure of the water-bearing capacity of a formation. However, with respect to water extraction and movement, it is not just the total magnitude of porosity that is important, but the size of the voids and the extent to which they are interconnected, as the pores in a formation may be open, or interconnected, or closed and isolated. For example, clay may have a very high porosity with respect to potential water content, but it constitutes a poor medium as an aquifer. More important in this respect are a formation's *Effective Porosity* (defined below) and its *Specific Retention*.

Porosity, Effective — The amount of interconnected pore space in a material available for fluid transmission; expressed as a percentage of the total volume occupied by the interconnecting interstices. Porosity may be primary, formed during deposition or cementation of the material, or secondary, formed after deposition or cementation, such as fractures.

Porous — (1) Containing pores, voids, or other openings which may or may not be inter-connected. (2) A condition which allows liquids to pass through.

Port — (1) A place on a waterway with facilities for loading and unloading ships; a city or town on a waterway with such facilities. Also, the waterfront district of a city. (2) A place along a coast that gives ships and boats protection from storms and rough water; a *Harbor*.

Positive Association — (Statistics) The direct relationship between two *Variables*, the values of which fluctuate together, in the same direction.

Positive Displacement Pump — A type of piston, diaphragm, gear or screw pump that delivers a constant volume with each stroke. Positive displacement pumps are used as chemical solution feeders.

Positive Estuary — An *Estuary* whose water has been measurably diluted from seawater by land drainage.

Post-Closure Plan — A document prepared by a hazardous waste treatment, storage, or disposal facility outlining the groundwater monitoring and reporting, waste containment provisions, and security arrangement for the 30-year period following closure.

Postchlorination — (Water and Wastewater Treatment) The addition of chlorine to the plant effluent, following plant treatment, for disinfection purposes.

Postdiluvian, also Postdiluvial — (Biblical) Existing or occurring after *The Flood*.

Postglacial — Relating to or occurring during the time following a glacial period.

Postobsequent Stream — A stream that follows the direction of the underlying strata, although the stream developed independently of the original relief and after the opposite-moving stream into which it flows.

Potable — Refers to water which is drinkable.

Potable Water — (1) Water that is safe and suitable to drink; drinking water. (2) Water that is drinkable; water that is safe and satisfactory for drinking and cooking; water that does not contain objectionable pollution, contamination, minerals, or infection, and is considered satisfactory for domestic consumption. (3) Specifically, freshwater that generally meets the standards in quality as established in the *U.S. Environmental Protection Agency (EPA) Drinking Water Standards* for drinking water throughout the United States. Potable water is considered safe for human consumption and is often referred to as *Drinking Water*. Freshwater that exceeds established chloride and dissolved solids limits is often referred to as slightly saline, brackish, or nonpotable water and is either diluted with fresher water or treated through a desalination process to meet potable-water standards for public supply. Also see *Drinking Water Standards*, *Drinking Water Standards [Nevada]*, *Water Contaminants*, *Water Treatment Disinfectants*, *Water Treatment Processes*, *Water Treatment Technologies*, *Water Quality Threats*, and *Waterborne Diseases*.

Potamology — The scientific study of rivers.

Potamon Zone — Stream reach at lower elevations characterized by reduced flow, higher temperature, and lower dissolved oxygen levels. Also see *Rhithron Zone*.

Potash Lake — A salt lake containing a high concentration of dissolved potassium salts.

Potency — Amount of material necessary to produce a given level of a deleterious effect.

Potential — (1) (Hydraulics) Any of several scalar variables, each involving energy as a function of position or condition; of relevance here is the fluid potential of groundwater. (2) (Water Quality) A water quality issue or problem identified by a river authority as being a potential problem, or a problem without current supporting data.

Potential Drop — Difference in total head between two *Equipotential Lines*.

Potential Energy — The energy available in a substance because of position (e.g., water held behind a dam) or chemical composition (hydrocarbons). This form of energy can be converted to other, more useful forms (for example, hydroelectric energy from falling water).

Potential Evapotranspiration — (1) The maximum quantity of water capable of being evaporated from the soil and transpired from the vegetation of a specified region in a given time interval under existing climatic conditions, expressed as depth of water. (2) The ideal maximum amount of water that will be lost from a particular area by *Evapotranspiration*, assuming sufficient water is available through precipitation. (3) The water loss that will occur if at not time there is a deficiency of water in the soil for use by vegetation.

Potential Natural Water Loss — The water loss during years when the annual precipitation greatly exceeds the average water loss. It represents the approximate upper limit of water loss from the type and density of vegetation native to a basin, under conditions of actual moisture supply and other basin characteristics, in contrast to *Potential Evapotranspiration* which represents a

hypothetical condition where there is no deficiency of water in the soil for use by the type and density of vegetation that would develop.

Potential Rate of Evaporation — The rate of evaporation under the existing atmospheric conditions from a surface of water that is chemically pure and has the temperature of the atmosphere. Also referred to as *Evaporativity*.

Potential Supply — That part of the resource base that has the potential for development or further expansion.

Potential Yield (or Well Capacity) — The maximum rate at which a well will yield water under a stipulated set of conditions, such as a given drawdown, pump, and motor or engine size. Well capacity may be expressed in terms of gallons per minute, cubic feet per second, or other similar units.

Potentiation — The effect of one chemical to increase the effect of another chemical.

Potentiometric Map — A map on which contour lines and other symbols are used to represent the *Potentiometric Surface* of an *Aquifer*. Also referred to as *Pressure-Surface Map*.

Potentiometric Surface — (1) An imaginary surface representing the total head of *Groundwater* in a *Confined Aquifer* that is defined by the level to which water will rise in a well. (2) An imaginary surface defined by the level to which water will rise in a well under its full pressure head, and representing the total static level of groundwater. Also referred to as a *Piezometric Surface* or *Pressure Surface*. (3) A surface which represents the static head of groundwater in tightly cased wells that tap a water-bearing rock unit (i.e., aquifer). In relation to an aquifer, the potentiometric surface is defined by the levels to which water will rise in tightly cased wells. If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The *Water Table* is a particular potentiometric surface for an *Unconfined Aquifer*. This term has generally replaced the term *Piezometric Surface*.

Pothole — (1) A rounded, steep-sided depression in a coastal marsh that contains water at or below the level at low tide. Also referred to as a *Rotten Spot*. (2) A large, shallow depression that occurs between dunes on a prairie and often contains an intermittent pond or marsh. Also see *Moulin*. (3) A deep hole or pit, especially a deep, round hole formed in the rock of a river bed by gravel whirling in water. (4) A rough hole formed in a road surface from a combination of weathering and the wear of vehicular traffic. Also referred to as *Chuckhole*.

Potometer — An apparatus for measuring the rate of transpiration in a plant by determining the amount of water absorbed.

POTW — See *Publicly Owned Treatment Works*.

POU — Point-of-Use.

Pour — (1) To make a liquid stream or flow, as from a container. (2) To rain hard or heavily.

Pour Point — The lowest temperature at which a liquid will pour under given conditions.

Powder — See *Powder Snow*.

Powder Snow — Dry, loose, fallen snow that was deposited under low temperature conditions and that has not been compacted in any way. Succinctly referred to as *Powder*.

PPB (ppb) — Parts per billion. Also $\mu\text{g/L}$ or micrograms per liter.

PPM (ppm) — Parts per million. Also mg/L or milligrams per liter.

Practically Irrigable Acreage (PIA) — The standard (as established in *Arizona v. California*, 373 U.S. 546 [1963], decreed in final form, 376 U.S. 340 [1964], decree amended, 383 U.S. 268 [1966], second supplemental decree entered, 466 U.S. 144 [1984]) for quantifying reserved water rights on an Indian reservation set aside with the intent that its inhabitants pursue agriculture [or, assumed by extension, water-related economic pursuits, e.g., fish hatcheries]. Under this standard Indian tribes are legally entitled to the amount of water needed to irrigate all practically irrigable acreage within their reservation boundaries. Furthermore, these water rights have a priority date equal to the date at which the reservation was established. Under the Winters Doctrine, which is the foundation of this policy, practically irrigable acreage must meet two criteria: (1) the land must be able to reasonably sustain crops; and (2) the cost of supply water to the crops must not be unreasonable. Also see *Winters Rights (Decision)* and *Water Law [Federal]*.

Prairie — A tract of level to hilly land that has a dominance of grasses and forbs, has a scarcity of shrubs, and is treeless. The natural plant community consists of various mixtures of tall, mid, and short growing native species, known as *true prairie*, *mixed prairie*, and *short-grass prairie*, respectively. Also see *Grasslands*.

Prairie Pothole — A geologic and geographic formation prevalent in the Northern Great Plains region of the United States stretching into Canada and characterized by a depression in the land formed thousands of years ago as a result of retreating *Glaciers* during the last *Ice Age*. These areas form a vast region of *Seasonal Wetlands* accommodating extensive bird populations during their migration and breeding seasons.

Pre Aeration — (Wastewater Treatment) The addition of air at the initial stages of treatment to freshen the wastewater, remove gases, add oxygen, promote flotation of grease, and aid coagulation.

Precautionary Drawdown — Release of water from a reservoir or other water impoundment facility initiated by projections that inflows will cause water in the structure to exceed desired levels.

Prechlorination — (1) (Water Treatment) The addition of chlorine at the headworks of a water treatment plant prior to other treatment processes. Done mainly for disinfection and control of tastes, odors, and aquatic growths, and to aid in coagulation and settling. (2) (Wastewater Treatment) The addition of chlorine in the collection system serving the plant or at the headworks of the plant prior to other treatment processes mainly for disinfection and control of tastes, odors, and aquatic growths and corrosion control. Also applied to aid disinfection, to reduce plant *Biochemical Oxygen Demand (BOD)* load, to aid in coagulation and settling, to control foaming in *Imhoff Units* and to help remove oil.

Precipitable Water — (1) The total atmospheric water vapor contained in a vertical column if the water were completely condensed. (2) The total water vapor contained in an atmospheric column of unit cross-sectional area; expressed in terms of water of the same cross-sectional area.

Precipitant — An agent added to a liquid mixture to encourage the formation of solid materials that will settle from the mixture. For example, alum (aluminum sulfate) is added to sewage to promote the formation of *Floc*, which facilitates the removal of organic materials from the wastewater.

Precipitate — (1) An insoluble, finely divided substance which is a product of a chemical reaction within a liquid. (2) The separation from solution of an insoluble substance. (3) A solid which forms from a liquid suspension as a result of a chemical reaction. The material (floc) is insoluble in water and will settle out over time.

Precipitation — (1) The process by which atmospheric moisture falls onto a land or water surface as rain, snow, hail, or other forms of moisture. (2) The downward movement of water in liquid or solid form from the atmosphere following condensation in the atmosphere due to cooling of the air below the dew point. Includes rain, snow, hail, and sleet. (3) As used in *Hydrology*, precipitation is the discharge of water, in liquid or solid state, from the atmosphere, generally onto a land or water surface. It is the common process by which atmospheric water becomes surface or subsurface water. The term “precipitation” is also commonly used to designate the quantity of water that is precipitated. Forms of precipitation include drizzle, rainfall, glaze, sleet, snow, graupel, small hail, and hail. Also, the process of separating mineral constituents from a solution by evaporation (halite, anhydrite) or from magma to form igneous rocks. (4) The chemical transformation of a substance in solution into an insoluble form (*Precipitate*).

Precipitation, Effective — In agriculture, that portion of the rainfall that remains in the soil and contributes to crop growth.

Precipitation Gage — A device used to collect and measure precipitation.

Precipitation, Initial — Precipitation at the beginning of a storm before the depression storage is fully filled up.

Precipitation, Intensity — The amount or rate of precipitation collected in a unit time interval.

Precipitation, Probable Maximum — The amount of precipitation that is the physical upper limit for a given duration over a particular basin.

Precision — (Statistics) The repeatability of a series of test results; whether the testing method gives the same answer under the same set of circumstances or sampling criteria.

Precursor — A compound that reacts in the atmosphere to form a pollutant.

Preference System — State laws or constitutional provisions which establish preferred use for water over other types of uses. Such systems typically rank domestic or municipal use as the highest, then agricultural use second, and industrial and mining uses next. See *Preferred Use* and *Designated Groundwater Basin*.

Preferred Use — A use given some sort of preference not given other uses. Preference can take many forms, depending on state law. One type of use, such as domestic use, may be preferred over others when there are competing applications to appropriate the same water. Persons having water rights for preferred use may be entitled to take water before those having rights for other uses, regardless of their relative priorities. A person needing water for a preferred use may be authorized to condemn (i.e., to buy in a forced judicial sale) water being used for non-preferred purposes. Also see *Designated Groundwater Basin* and *Designated Groundwater Basin [Nevada]*.

Preferred Use [Nevada] — In the interest of public welfare, the state engineer is authorized and directed to designate preferred uses of water within the respective areas so designated by him and from which the groundwater is being depleted. In acting on applications to appropriate groundwater, he may designate such preferred uses in different categories with respect to the particular areas involved within the following limits: domestic, municipal, quasi-municipal, industrial, irrigation, mining and stock-watering uses and any uses for which a county, city, town, public water district or public water company furnishes the water.

Preheating — Heating of feedwater prior to desalting in a membrane process in order to render desalting more efficient.

Preliminary Risk Assessment — (Dam Safety) As applied to dam safety, the process of identifying the downstream hazard potential for the purpose of classifying a dam.

Preliminary Settlement Agreement (PSA) [Nevada] — An agreement reached between the Pyramid Lake Paiute Tribe of Indians and Sierra Pacific Power Company (SPPCo) on May 23, 1989. The PSA provides SPPCo the ability to store its water rights in federally operated reservoirs along the Truckee River in California at times when it is not needed for municipal and industrial (M&I) water supply in the Reno–Sparks Metropolitan Area. In exchange, excess water in storage is used for fishery purposes when drought conditions are not in effect. Also, SPPCo forgoes its right to single-use hydroelectric flows in the Truckee River under the *Orr Ditch Decree [Nevada and California]*, thereby enabling the United States and the Tribe to store water for fishery benefit at certain times of the year. The PSA is incorporated into *Public Law 101–618* (the *Negotiated Settlement*) by reference.

Preliminary Treatment — (Wastewater Treatment) The removal of metal, rocks, rags, sand, eggshells, and similar materials which may hinder the operation of a treatment plant. Preliminary treatment is accomplished by using equipment such as racks, bar screens, comminutors, and grit removal systems.

Prescribed Fire (or Burning) — The intentional burning of forest or grassland fuels under conditions specified in an approved plan to meet management objectives and confined to a predetermined area; ignition may be either the result of a scheduled management activity or from other sources (e.g., lightning).

Prescribed Water Rights — (1) Water rights to which legal title is acquired by long possession and use without protest of other parties. (2) Water use rights gained by trespass or unauthorized taking that ripen into a title; on a par with rights to land gained through adverse possession. To perfect the right, the use of water must be adverse, hostile, open and continuous for five continuous years against the recognized water rights holder. Contrast with *Appropriative Water Rights*, *Riparian Water Rights*, and *Littoral Water Rights*.

Prescription — A method of acquisition of title or the use of water by immemorial or long-continued enjoyment. The right of prescription may not exist where water rights laws and a strict permitting process is enforced.

Prescriptive Water Rights — Water rights which are acquired by diverting water and putting it to use in accordance with specified procedures. These procedures include filing a request to use unused water in a stream, river or lake with a state agency.

Presedimentation — (Water Quality) A pretreatment process used to remove gravel, sand, and other gritty material from raw water before it enters the main treatment plant. This is usually done without the use of coagulating chemicals.

Preservation — (1) The protection and propagation of game, fish, forests, etc. Also applies to the protection of habitats for such flora and fauna. (2) The natural resources policy that stresses the aesthetic aspects of forests, rivers, wetlands, and other areas and tends to favor leaving such areas in an undisturbed state. (3) The protection of ecologically important wetlands or other aquatic resources in perpetuity through the implementation of appropriate legal and physical mechanisms. Preservation may include protection of upland areas adjacent to wetlands as necessary to ensure protection and/or enhancement of the overall aquatic ecosystem. Compare with *Conservation*.

Preservative — A chemical added to a water sample to keep it stable and prevent compounds in it from changing to other forms or to prevent microorganism densities from changing prior to analysis.

Pressure (*p*) — Force per unit area. Enclosed fluids exert a force perpendicular to the surface of the containing vessel. The shape of the container does not affect the fluid pressure.

Pressure Control — A switch which operates on changes in pressure. Usually this is a diaphragm pressing against a spring. When the force on the diaphragm overcomes the spring pressure, the switch is actuated (activated).

Pressure Filter — (Water Quality) A device used to remove fine particulate matter from water. The filter consists of a filter medium, such as sand or anthracite coal, packed in a watertight vessel.

Pressure Filtration — (Water Quality) A process by which liquid is removed from a sludge by using external pressure to force it through a filter.

Pressure Gage — An instrument, graduated in any units desired, for registering the pressure of solids, liquids, or gases.

Pressure Gradient — The change in pressure with distance, from lower to higher pressure, or vice versa.

Pressure Grouting — The positive placement of grout by introducing the grout at the bottom of the void to be grouted.

Pressure Head — (1) The relative pressure (excess over atmospheric pressure) divided by the unit weight of water; expressed in units of height. (2) The vertical distance (in feet) equal to the pressure (in psi) at a specific point. The pressure head is equal to the pressure in psi times 2.31 ft/psi.

Pressure Ice — (Oceanography) Pack ice that exhibits differential movement in different parts of the pack, caused by contact with land or by varying atmospheric or ocean conditions, and resulting in shifting and deformation of the ice. Typical resultant forms of this process are hummocks, pressure ridges, rafted ice, ropak, tented ice, and weathered ice.

Pressure Relief Pipes — Pipes used to relieve uplift or *Pore Pressure* in a dam foundation or in the dam structure.

Pressure Ridge — A ridge of glacier ice formed by horizontal pressure associated with the flow of the *Glacier*.

Pressure Sewers — A system of pipes in which water, wastewater, or other liquid is pumped to a higher elevation.

Pressure, Static — Pressure exerted by a fluid at rest.

Pressure Surface — See *Potentiometric Surface*.

Pressure-Surface Map — See *Potentiometric Map*.

Pressure Tube — A narrow, deep, cylindrical hole formed in a glacier when a stone that has become warmer than the surrounding ice sinks.

Pressurized (Piped) Irrigation Systems — One of the most common forms of irrigation systems encompasses the use of sprinkler systems which can be used for almost all crops. In order to achieve high distribution uniformity (DU), the systems must be designed to have minimal pressure variation, which ensures uniform flow rates from the sprinkler heads. The following constitutes the more common variations of the sprinkler systems:

- [1] **Permanent Systems** — These systems use underground pipelines with risers connected to an underground lateral, usually with a sprinkler head attached less than a foot from the ground surface. Commonly used for orchard irrigation (under the tree), but when connected to taller risers they can be used for vines.
- [2] **Solid Set Systems** — These systems use above ground aluminum pipelines, usually in 30-foot sections. Short risers connect the aluminum laterals to sprinkler heads. With a solid set system, the irrigation system covers a complete field and may stay in the field for the entire growing season, only being moved before harvest time. This system is used mainly for field and truck crops.
- [3] **Hand Move Systems** — Similar to the solid set systems, also using aluminum pipelines, but typically do not cover a whole field. After an irrigation period, the sprinkler laterals are disconnected from the sub-mains and moved by hand to the next location in the field. These systems are usually designed for each part of the field to receive irrigation water every 7-14 days and are used on field crops, truck crops, and orchards.
- [4] **Wheeled Systems** — These systems have the lateral, risers, and sprinkler heads all mounted on wheels that can be moved throughout the field during the irrigation season. Side roll systems are designed to be stationary during the irrigation. After the irrigation, they are moved (using and attached or on-board engine) to the next location.
- [5] **Linear Move Systems** — These systems have the lateral, risers, and sprinklers mounted on pipes between large wheeled towers. The system continuously travels down the field during irrigations. The water is usually supplied to the system via a canal parallel to the travel of the system.
- [6] **Center Pivot Systems** — These systems are similar in structure to linear move systems, except instead of the lateral traveling down the field, it travels in a circle in the field. One end of the lateral is fixed in the middle of the field, where the water enters the lateral. The entire lateral rotates around this pivot (which is usually a well), and continuously moves during irrigation.
- [7] **Low-Energy Precision Application Systems (LEPA)** — LEPA systems are similar to linear move sprinkler systems, except that they have drop tubes from the lateral to the soil surface instead of sprinkler heads. These systems are used in fields that have furrows, sometimes with small checks or dams in the furrow. The LEPA system travels

perpendicularly to the furrows, and drop tubes emit water uniformly into the furrows.

- [8] **Micro-Irrigation (Low Volume) Systems** – These systems frequently constitute the predominant irrigation method in areas with trees and vines. These systems have many of the same components of sprinkler systems: pressurized water sources, filters, main pipelines, sub-mains, and laterals. The main difference is the devices that emit the water to the soil. These systems emit water at a very low flow rate of from 0.5 to 10 gallons per hour. Two basic system types are used, drip and micro-spray. With drip devices, or emitters, water flows out as a constant stream (0.5 to 2 gallons per hour) directly to the soil. With micro-spray, the devices or spray heads produce a spray of from 4 to 20 gallons per hour over the soil surface. Also, in such systems the entire main and sub-main pipelines are usually underground rigid plastic pipe, the laterals are flexible plastic hose, and the filters are designed to remove much smaller particles to prevent clogging emitters and spray heads.

Pressurized Water Reactor (PWR) — A nuclear reactor in which water, heated by nuclear energy, is kept at high pressure to prevent the water from boiling. Steam is then generated in a secondary coolant loop and subsequently this steam is used to turn a turbine which generates electricity.

Presumptive Remedies [EPA] — Preferred technologies for common categories of sites, based on historical patterns of remedy selection and *U.S. Environmental Protection Agency's (EPA)* scientific and engineering evaluations of how well technologies perform.

Presumptive Test — (Water Quality) The first of three steps in the analysis of water or wastewater for the presence of bacteria of fecal origin. Portions of a water sample are inoculated into lactose broth and incubated for 24 hours at 37EC (98.6EF). The presence of acid and gas after that time is a positive test, and the water is presumed to be contaminated. Also see *Confirmed Test* and *Completed Test*.

Pretreatment — (1) Under the *Clean Water Act (CWA)*, the required alteration and/or reduction of certain water pollutants in a waste stream before the wastewater is discharged into a *Publicly Owned Treatment Works (POTWs)*. The purpose of this requirement is to prevent discharges that will reduce the efficiency of the water treatment facility or to treat materials that are not treated or inadequately treated by the facility. (2) Treatment of feedwater prior to desalting, for example, removal of iron and manganese prior to electrodialysis.

Pretreatment Facility — (Wastewater Treatment) Industrial wastewater treatment plant consisting of one or more treatment devices designed to remove sufficient pollutants from wastewaters to allow an industry to comply with effluent limits established by the *U.S. Environmental Protection Agency (EPA)* General and Categorical Pretreatment Regulations or locally derived prohibited discharge requirements and local effluent limits. Compliance with effluent limits allows for a legal discharge to a *Publicly Owned Treatment Works (POTW)*.

Prevailing Current — (Oceanography) The flow most frequently observed at a place during a specified period of time.

Price (or Pygmy) Current Meter — A (water) current meter with a series of conical cups fastened to a flat framework through which a pin extends. Flowing water rotates the cups around the pin in a horizontal plane, and acoustical or electrical devices register the number of revolutions, from which the velocity of the water can be computed.

Price Elasticity (of Water) — Defined as the ratio of the percent change in the quantity demanded of water (or any other economic good) and the percent change in price, or

$$n_{\text{water}} = \text{Percent Change in } Q_{\text{water}} / \text{Percent Change in } P_{\text{water}}$$

An elastic demand results when the ratio of n_{water} is greater than unity (>1), implying that a given change in price will result in a greater (percentage) change in the quantity demanded. Under such conditions of “elastic demand” for water, consumers tend to be responsive to changes in the price for water. Conversely, an inelastic demand results when the ratio of n_{water} is less than unity (<1), implying that a given change in price will result in a smaller (percentage) change in the quantity demanded. Under such conditions of “inelastic demand,” consumers are relatively unresponsive to changes in the price for water. Along any given (downward sloping) demand curve, the elasticity will vary from inelastic, to unity, to elastic as the price rises further.

Primacy — (1) (General) The responsibility for ensuring that a law is implemented, and the authority to enforce a law and related regulations. A primacy agency has the primary responsibility for administering and enforcing regulations. (2) (Environmental) Term used to denote that individual states have been delegated the authority to implement the requirements, as prescribed by the *U.S. Environmental Protection Agency (EPA)*, of the *Safe Drinking Water Act (SDWA)* and amendments thereto. (3) Primary enforcement responsibility for administration and enforcement of the primary drinking water regulations and related requirements applicable to public water systems within a state.

Primacy Agency — The agency authorized by law to enforce federal drinking water regulations in a state.

Primacy State — Agent with authority and jurisdiction to dictate drinking water criteria and standards to public water systems. The State has primacy in most cases, otherwise the *U.S. Environmental Protection Agency (EPA)* has primacy authority.

Primary Clarifier — (Wastewater Treatment) A wastewater treatment device which consists of a rectangular or circular tank that allows those substances in wastewater that readily settle or float to be separated from the wastewater being treated.

Primary Cost — (FEMA) The cost of providing the basic floodproofing feature – elevation, flood shield, floodwall or levee.

Primary Data — (Data Analysis) Typically, data acquired by direct interaction, such as direct observation through measurements, tabulation, or surveys. Contrast with *Secondary Data*.

Primary Drinking Water Regulation — Applies to public water systems and specifies a contaminant level, which, in the judgement of the *U.S. Environmental Protection Agency (EPA)* Administrator, will not adversely affect human health.

Primary Drinking Water Standards — Enforceable standards related directly to the safety of drinking water; set by the U.S. Environmental Protection Agency (EPA). Also see *Drinking Water Standards* and *Drinking Water Standards [Nevada]*.

Primary Element — An instrument which measures (senses) a physical condition or variable of interest. Floats and thermocouples are examples of primary elements. Also called a *Sensor*.

Primary Frontal Dune — A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively mild slope.

Primary Maximum Contaminant Level (PMCL) — Primary MCLs for various water quality indicators are established to protect public health.

Primary Productivity — A measure of algal productivity or rate of growth in a body of water, the primary productivity measures the mass of carbon used annually by algae per unit area of lake surface. This measure, also referred to as the *Algal Growth Rate*, is expressed as an index figure in grams of carbon per square meter per year, and indicates the state of *Eutrophication* of a body of water. Algal productivity is influenced by the quantities of nutrients that flow into, or fall onto, the lake each year and the number of days of sunshine. Another important factor is the mixing of the lake, which brings up to the surface where algae exist nutrients which have accumulated near the bottom of the lake.

Primary Settling Tank — (Water Quality) A holding tank where raw sewage or other wastewater is retained to allow the settling and removal of particulate material. The material that separates from the suspension is often termed *Sludge*.

Primary Sludge — The *Sludge* produced by primary treatment in a wastewater treatment plant.

Primary Standards — (Water Quality) Standards set by the U.S. *Environmental Protection Agency (EPA)* for the maximum amount of pollutants that can be present in air and water without adverse health effects on humans. The primary standards for drinking water are set for 20 materials, ranging from arsenic to fluoride and from pesticides to radionuclides. Compare to *Secondary Standards*.

Primary Succession — The development of plant and animal communities in a land area that does not contain topsoil, for example in an area covered by lava that has solidified. This type of succession depends on the slow weathering of rock through weathering or biological processes. Compare with *Secondary Succession*.

Primary Treated Water — First major treatment in a wastewater treatment facility, usually sedimentation but not biological oxidation.

Primary Wastewater Treatment — (Water Quality) The removal of particulate materials from domestic wastewater, usually done by allowing the solid materials to settle as a result of gravity. Typically, the first major stage of treatment encountered by domestic wastewater as it enters a treatment facility. The wastewater is allowed to stand in large tanks, termed *Clarifiers* or *Primary Settling Tanks*. Primary treatment plants generally remove 25 to 35 percent of the *Biological Oxygen Demand (BOD)* and 45 to 65 percent of the total suspended matter. Also, any process used for the decomposition, stabilization, or disposal of sludges produced by settling. The water from which solids have been removed is then subjected to *Secondary Wastewater Treatment* and possibly *Tertiary Wastewater Treatment*.

Prime — The action of filling a pump casing with water to remove the air. Most pumps must be primed before startup or they will not pump any water.

Prime Agricultural Lands [NRCS] — Lands classified by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) that are in one of the following categories:

- [1] Lands rated as either Class I or Class II in the *Natural Resources Conservation Service (NRCS) Land Capability Classification* system;
- [2] Lands that support livestock used for the production of food and fiber and which have an annual carrying capacity equivalent to at least one animal unit per acre as defined by the U.S. Department of Agriculture; or
- [3] Lands planted with fruit of nut-bearing trees, vines, brush or crops which have a commercial-bearing period on an annual basis.

Prime Farmland — As defined in the *Farmland Protection Policy Act of 1981*: Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses (urban areas are not included). It has the soil quality, growing season, and moisture supply needed for the economic production of sustained high yields of crops when treated and managed (including water management) according to acceptable farming methods. Prime farmland includes land that is being used currently to produce livestock and timber, but it excludes land committed to urban development or water storage.

Prime Water — Generally, any water delivered via a canal to a headgate; irrigation water released from storage for deliver to a headgate.

Priming — (1) The first filling or first seasonal filling of a canal, reservoir, or other structure with water. (2) Starting the flow, as in a pump or siphon.

Priming of the Tides — (Oceanography) The periodic speeding up of the time of occurrence of high and low water (caused by changes in the relative positions of the moon and sun), resulting in the arrival of high water before the moon reaches its zenith.

Primitive Water — Water that has been entrapped in the earth's interior since its formation.

Principle of Constant Proportions — (Oceanography) The relationship to one another of the ions of conservative elements, such as sodium, chloride, sulfate, magnesium, calcium, and potassium, whose ratios are almost invariable in open ocean water, regardless of variations in total salinity. Also referred to as *Marcel's Principle* or the *Law or Rule of Constant Proportions*.

Principal Spillway — Allows discharge of water from a reservoir when the water level exceeds the top of the spillway. Principal spillways are used to allow small inflows to be released from the reservoir. Also see *Spillway*.

Principal Threats [EPA] — Source materials considered by the U.S. *Environmental Protection Agency (EPA)* to be highly toxic

or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

Prior Appropriation Doctrine — (1) A doctrine of water law that allocates the right to use water on a first-come first-serve basis. (2) A concept in water law under which a right to a given quantity of water is determined by such a procedure as having the earliest *Priority Date*. (3) A legal process which allocates water rights to the first party who diverts water from its natural source and applies the water to beneficial use. If at some point the first appropriator fails to use the water beneficially, another person may appropriate the water and gain rights to the water. The central principle is beneficial use, not land ownership. (4) The system for allocating water to private individuals used in most of the western United States. The doctrine of *Prior Appropriation* was in common use throughout the arid west as early settlers and miners began to develop the land. The prior appropriation doctrine is based on the concept of “*First in Time, First in Right*”. The first person to take a quantity of water and put it to *Beneficial Use* has a higher priority of right than a subsequent user. Under drought conditions, higher priority users are satisfied before junior users receive water. Appropriative rights can be lost through nonuse; they can also be sold or transferred apart from the land. Contrast with *Riparian Doctrine* and *Riparian Water Rights*. Also see *Littoral Water Rights* and *Prescribed Water Rights*.

Priority — The concept that the person first using water has a better right to it than those commencing their use later. An appropriator is usually assigned a “priority date”. However, the date is not significant in and of itself, but only in relation to the dates assigned other water users from the same source of water. Priority is only important when the quantity of available water is insufficient to meet the needs of all those having a right to use water. See (*Prior Appropriation Doctrine* and *Appropriative Water Rights*).

Priority Date — The date of establishment of a water right; the officially recognized date associated with a water right. The rights established by application have the application date as the date of priority. Relative to other water rights, the priority date may make a water right senior (predating other rights) or junior (subordinate to other rights). See (*Prior Appropriation Doctrine* and *Appropriative Water Rights*).

Priority of Appropriation — As between appropriators, the first in time is the first in right. The priority of the appropriation shall date from the time of filing of the application therefor in the office of the water management board.

Priority of Use and Statutory Preferences — Under appropriation water law systems, priority of use refers to the date a water right is acquired, with senior rights prevailing over junior rights. Priority of use must be distinguished from statutory preferences (designations), which refer to statutory statements of preference among types of beneficial use and would come into play, for example, in deciding which of two concurrent water rights should be satisfied first during a shortage of water or which of two competing applications for a water right should be granted.

Priority Pollutants — (Water Quality) (1) A list of over 125 chemicals in 65 classes of chemical materials defined as toxic pollutants by Section 307 of the 1977 *Clean Water Act (CWA)*, which also requires technology-based effluent standards for the control of these chemicals. (2) The *U.S. Environmental Protection Agency (EPA)* has proposed a list of priority toxic pollutants. These substances are an environmental hazard and may be present in water. Because of the known or suspected hazards of these pollutants, industrial users of the substances are subject to regulation. The toxicity to humans may be substantiated by human epidemiological studies or based on effects on laboratory animals related to carcinogenicity, mutagenicity, teratogenicity, or reproduction. Toxicity to fish and wildlife may be related to either acute or chronic effects on the organisms themselves or to humans by bioaccumulation in food fish. Persistence (including mobility and degradability) and treatability are also important factors.

Pristine — (Ecology) No trace of human activities; landscape alterations from natural ecological processes only.

Private Stream — A stream that diverts all or part of the drainage of another stream.

Probabilistic Process — The process in which the probability of occurrence of the variables is taken into consideration and their sequence of occurrence is ignored.

Probability — (1) The likelihood that a given event will occur. (2) (Statistics) A number expressing the likelihood that a specific event will occur, expressed as the ratio of the number of actual occurrences to the number of possible occurrences.

Probability Distribution — The frequency distribution divided by the total number of occurrences (observations), provided that the latter tends to infinity.

Probability of Detection — The likelihood, expressed as a percentage, that a test method will correctly identify a leaking tank.

Probability of Precipitation (PoP) — The likelihood of occurrence (in percent) of a measurable amount (0.01 inch (0.03 cm) or greater) of liquid precipitation (or melted equivalent of frozen precipitation) at a point during a specified period of time (usually 6 or 12 hours). The following listing presents the PoPs (percentages) expressed in degrees of uncertainty with an areal qualifier:

Percent Probability	Precipitation Likelihood
10%	Few isolated
20%	Slight chance widely scattered
30-50%	Chance scattered
60-70%	Likely numerous
80-100%	Most likely to be extensive

Probable Maximum Flood (PMF) — (1) The largest flood for which there is any reasonable expectancy in a particular climatic era. (2) The most severe flood that may be expected from a combination of the most critical meteorological and hydrological

conditions that are reasonably possible in the drainage basin. It is used in designing high-risk flood protection works and siting or structures and facilities that must be subject to almost no risk of flooding. The probable maximum flood is usually much larger than the 100-year flood.

Probable Maximum Precipitation (PMP) — (1) The maximum amount of precipitation for a given period that can reasonably be expected to occur in a specific drainage basin. (2) The precipitation that may be expected from the most severe combination of critical meteorologic conditions that are reasonably possible in an area as found in the National Weather Service Hydrometeorological Report No. 51, “Probable Maximum Precipitation Estimates, United States East of the 105th Meridian”; or Hydrometeorological Report No. 55, “Probable Maximum Precipitation Estimates, United States Between the Continental Divide and the 103rd Meridian”.

Process Fluid Stabilization [Nevada] — The condition which results when contaminants in any fluid, including meteoric waters (i.e., precipitation), which are intentionally or unintentionally introduced into any heap leaching or tailings facility are bound or contained or otherwise treated so as to prevent them from degrading the waters of the state under the environmental conditions that may be reasonably expected at the site.

Process Geomorphology — See *Geomorphology*, *Process*.

Process Variable — A physical or chemical quantity which is usually measured and controlled in the operation of a water treatment plant or industrial plant.

Process Verification — Verifying that process raw materials, water usage, waste treatment processes, production rate and other facts relative to quantity and quality of pollutants contained in discharges are substantially described in the permit application and the issued permit.

Process Wastewater — Any water that comes into contact with any raw material, product, byproduct, or waste.

Process Water — (1) Any water that comes in contact with a new material or product. The water is often released as wastewater following use. (2) Water that may have chemicals, sewage, metals, or any other material added to it during the use of the water in an operation.

Produced Water — As crude oil is extracted from a well, the water that comes to the surface with the oil. The produced water can constitute a large fraction of the total fluids extracted, and it is either pumped back into an underground formation via an *Injection Well* or discharged to surface water.

Product Water — (1) Output water of a desalting or water treatment plant. (2) Water that has passed through a water treatment plant. All the treatment processes are completed or finished. This water is the product from the water treatment plant and is ready to be delivered to the consumers. Also called *Finished Water*.

Production (also Producing) — The act of extracting *Groundwater* by pumping or otherwise.

Profile — (1) A graph showing variation of elevation with distance along a traverse or profile cross section. Also referred to as a flood profile if drawn for a specific flood or level of flooding. (2) A vertical section of a body of surface water or of any *Potentiometric Surface*, such as a *Water Table*. (3) A drawing showing elevation plotted against distance, such as the vertical section or side view of a pipeline.

Profile of Equilibrium — (1) The longitudinal profile of a graded stream or a stream having a gradient that is sufficient to maintain a balance between the amount of material the stream can transport and the amount of material supplied. Also referred to as an *Equilibrium Profile* or *Graded Profile*. (2) (Geology) The slope of the floor of a body of water, taken in a vertical plane, having a gradient that is sufficient to maintain a balance between deposition of sediment and erosion by waves and currents.

Profiling Snow Gauge — A radioactive gauge used for measuring the water equivalent and density-depth distribution of a snow cover. Also referred to as *Nuclear Twin-Probe Gauge*.

Profundal Zone — (Ecology) (1) The section of a freshwater ecosystem where little sunlight penetrates. Generally it is found in deep-water systems such as lakes; in ponds and other shallow systems it is usually absent. (2) The deep, bottom-water area beyond the depth of effective light penetration. Includes all the lake floor beneath the *Hypolimnion*. (3) The sediments beyond the *Littoriprofundal Zone*.

Proglacial — Referring to the area directly in front of or just beyond the outer margin of a *Glacier* or ice sheet, and the deposits or other features formed by or derived from the glacier ice.

Prograding Shoreline — (Geology) A shoreline in the process of being built seaward or lakeward by deposition and accumulation.

Programmatic Conservation — Conservation that results from public education efforts that influence consumer behavior. Examples include turning off the water when brushing your teeth, washing only full loads of laundry, fixing leaks, etc.

Project Conveyance Efficiency — The project conveyance efficiency is an expression representing those “losses” (seepage, operation spills, evaporation, etc.) experienced by an irrigation project conveyance system while transporting water from the diversion point to the farm headgate(s). $\text{Project Conveyance Efficiency} = (\text{Total Farm Headgate Delivery (in acre-feet per year)}) / (\text{Total Diversion for Irrigation at Dam (in acre-feet per year)})$ expressed as a percentage.

Project Crop Water Requirement — The project crop water requirement is the annual amount of water required to meet the total project’s crop consumptive use plus leaching requirement, and adjusted for natural precipitation (expressed in acre-feet per year).

Project Dependable Capacity (PDC) — The power capacity that a hydropower system can reliably deliver at any time. Due to the uncertainties inherent in hydrologic forecasting, and hence reservoir system inflows, defining what is meant by a reliable power capacity is crucial is this determination and requires extensive computer modeling of historical inflows to the storage system.

Project Efficiency — The project efficiency is a general term referring to the efficiency relating to all aspects of a project’s use of water.

Project Evaluation Period — Expected useful life of a project beginning at the end of the installation of the project.

Project Installation Period — The time period required for construction and installation of a project.

Project Farm Headgate Requirement — The project farm headgate requirement is that amount of water (in acre-feet per year)

required at all farm headgates of the project. Project crop water requirement is adjusted for average project farm irrigation efficiency to arrive at this figure: *Project Farm Headgate Requirement* = *Project Crop Water Requirement* divided by the *Average Project Farm Irrigation Efficiency* expressed in acre-feet per year.

Project WET (Water Education for Teachers) [Nevada] — A statewide supplementary, interdisciplinary water education program with components for the education community (K–12) and the general public. The goal of *Nevada Project WET* is to facilitate and promote the awareness, appreciation, knowledge, and stewardship of Nevada's water resources through the development and dissemination of classroom-ready teaching aides, teacher training, learning materials, and demonstration models as well as the maintenance of a resource bureau. The program is designed to provide useful, unbiased information in a straight-forward, neutral fashion addressing a wide variety of water-related topics to include: atmospheric water, surface water, groundwater, water conservation, water pollution, water laws, water users, and competition for limited water resources. *National Project WET* at Montana State University coordinates the individual state WET programs. The Nevada Division of Water Planning (Department of Conservation and Natural Resources), along with the Nevada Cooperative Extension, National Project WET, and the International Office for Water Education, sponsor the Nevada Project WET program. Other water education programs include International Office for Water Education (IOWE) established at Utah State University in 1983 to promote water/science education and the U.S. Geological Survey's (USGS) National Water Information Clearinghouse (NWIC) which was established to serve as a focus for the dissemination of water resource information to all levels of government, academia, the private sector, and the general public.

Project Yield — The water supply attributed to all features of a project, including integrated operation of units that could be operated individually. Usually, but not always, it is the same as the firm water yield. Also see *Dependable Supply* and *Firm Yield*.

Projection — (Mathematical) Calculations made into the future based on current events and trends. Also see *Extrapolate/Extrapolation*.

Promontory — A high ridge of land or rock jutting out into a body of water; a headland.

Proof of Beneficial Use — A part of the water right application and permitting process which documents that the water permitted for use has been applied to *Beneficial Use*. Generally, this process is followed by the issuance of the water right certificate (*Perfected Water Right*).

Proof of Appropriation — Part of the water right application and permitting process which attests to the fact that water has been withdrawn for the use specified in the original permit request.

Proper Functioning Condition — Refers to the functioning condition of *Riparian* areas and *Wetlands* being a result of the interactions among geology, soil, water, and vegetation. Riparian/wetland areas are functioning properly when adequate vegetation is present to dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality; filter sediment and aid *Floodplain* development; improve floodwater retention and groundwater recharge; develop root masses that stabilize streambanks against cutting actions; develop diverse pond and channel characteristics to provide habitat and the water depth, duration and temperature necessary for fish production, waterfowl breeding and other uses; and support greater *Biodiversity*.

Property Right — A generic term that refers to any type of a right to specific property, whether it is personal or real property, tangible or intangible. As an example, a landowner has a property right to use water attached to his or her land.

Propylitic — (Geology) A type of *Hydrothermal* alteration characterized by the formation of calcite, chlorite, epidote, serpentine, quartz, pyrite, and iron oxides.

Proton — An elementary particle with a single positive electrical charge and a mass approximately 1,847 times that of the electron. The atomic number of an atom equals the number of protons in its nucleus.

Protozoa — (1) Small, one-celled animals including amoebae, ciliates, and flagellants. (2) Microscopic animals that occur as single cells. Some protozoa can cause disease in humans. Protozoa form cysts, which are specialized cells like eggs that are very resistant to chlorine. Cysts can survive the disinfection process, then "hatch" into normal cells that can cause disease. Protozoa must be removed from drinking water by filtration, because they cannot be effectively killed by chlorine.

Provenance — For sediment, the source area or source bedrock or source sediment.

Province — (1) (Oceanography) A general term for a division of the ocean based on the physical characteristics of the ocean environment itself, as distinguished from life-zone divisions such as *Littoral*, *Neritic*, or *Pelagic*. (2) (Geology) See *Physiographic Province*. (3) (Ecology) An ecological unit at the regional scale of assessment controlled mainly by continental weather patterns.

Prussian Blue — A blue paste or liquid (often on a paper like carbon paper) used to show a contact area. Used to determine if gate valve seats fit properly.

Psephyte — (1) A lake-bottom deposit made up primarily of coarse, fibrous plant remains. (2) (Geology) A sediment or sedimentary rock equivalent to a rudite, and made up of large, coarse fragments set in a variable matrix. Also referred to as *Psephite*.

Pseudomorphs — (Geology) A mineral whose outward crystal form is that of another mineral species, typically as a result of *Hydrothermal* alteration.

psi — Pounds per Square Inch. A unit of pressure.

PSIG — Pounds per Square Inch of Gage pressure. The pressure within a closed container or pipe measured with a gage in pounds per square inch. See *Gage Pressure*.

Psychrometer — A *Hygrometer* used to determine relative humidity of the atmosphere. It usually consists of two thermometers, one wet and one dry bulb, with the wet bulb wrapped in a cloth wick saturated with water which, due to evaporation, causes the temperature to fall below that of the air. From this difference in temperature and the use of specially prepared tables, the relative humidity can be determined.

Public Domain (Lands) — Referring to all the lands of the United States which the federal government obtained by cession from:

- [1] 13 Original States (1789–1802);
- [2] Louisiana Purchase (1803);
- [3] Cession from Spain (1819);
- [4] Occupation of the Oregon Territory (1846);
- [5] Mexican Cession (1848);
- [6] Purchase from Texas (1850);
- [7] Gadsen Purchase (1853); and
- [8] Purchase of Alaska (1867).

Public Interest, or Public Welfare — An interest or benefit accruing to society generally, rather than to any individuals or groups of individuals in the society. In many states, a permit to appropriate water must be denied if the appropriation would be contrary to the public interest or public welfare. These terms are sometimes vague and state engineers or others administering the water permit systems generally have viewed narrowly the authority granted under such provisions. In some cases they have restricted their consideration to matters of economic efficiency or the effects of the proposed appropriation on existing or future use for the water and have not considered such things as the environmental effects. However, recent developments, such as state environmental policy acts or legislation addressing specific public interest criteria, have placed new emphasis on this issue. Also see *Public Trust Doctrine*.

Public Involvement — The process of obtaining citizen input into each stage of the development of a planning document. Under the *National Environmental Policy Act (NEPA)*, such inputs are required as part of any *Environmental Impact Statement (EIS)* process.

Public Land Survey System (PLSS) — The description of the location of land using the survey system (public land survey system) of the United States Government and includes the 40-acre subdivision within a *quarter*, *section*, *township* and *range*. The public land survey system is based on the concept of a township as a square parcel of land six miles on each side. Its location is established as being so many six-mile units east of a north-south line (called the *meridian*) and so many six-mile units north or south of an east-west line (called the *baseline*). The township is described by township and range, e.g., T.4N, R.23E. Each township is further divided into 36 parts called sections one mile square (each section measuring 5,280 feet on each side). A typical section containing 640 acres may be further subdivided into quarters (measuring 2,640 feet on each side). The quarter of a section is equal to 160 acres and described as the NW $\frac{1}{4}$ or the NE $\frac{1}{4}$ or the SW $\frac{1}{4}$ or the SE $\frac{1}{4}$ of that particular section. The quarter section may be divided into four quarters, each being $\frac{1}{16}$ of a section, or 40 acres (measuring 1,320 feet on each side). Each sixteenth is described as the NW $\frac{1}{4}$ or the NE $\frac{1}{4}$ or the SW $\frac{1}{4}$ or the SE $\frac{1}{4}$ of that particular quarter section. A person must determine which is north on a map (usually at the top) in this case the easterly direction would be to the right, south to the bottom, and west to the left. The written location of a specific 40-acre parcel of land would be NW $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 13, T.4N., R.23E. Some sections may contain more or less acreage than 640. Also see *Local (Test-Well) Site Designation [Nevada]* for the use of the PLSS is denoting test-well site locations.

Public Law 92–500 (PL 92–500) — The *Water Pollution Control Act* of 1972 which set goals and timetables for attaining water quality standards. See *Water Pollution Control Act*.

Public Law 93–523 (PL 93–523) — The *Safe Drinking Water Act (SDWA)* of 1974 which established primary and secondary quality standards for drinking water. See *Safe Drinking Water Act (SDWA)*.

Public Law 101–618 (PL 101–618) [Nevada and California] — Omnibus legislation passed by the 101st Congress at the end of its 1990 session intended to settle a number of outstanding disputes concerning the Truckee and Carson Rivers. The legislation authorized an ambitious environmental restoration program to benefit the *Lahontan Valley Wetland System [Nevada]* and Pyramid Lake and the lower Truckee River. It also established a framework for resolving separate by closely-related water-resource conflicts involving the Pyramid Lake Paiute and Fallon Paiute–Shoshone Tribes, the cities of Reno and Sparks (Nevada), the states of Nevada and California, and (pending the resolution of several as-yet unsatisfied controversies) the *Newlands (Irrigation) Project [Nevada]*. The legislation contains two primary titles: *TITLE I — The Fallon Paiute–Shoshone Indian Tribal Settlement Act*; and *TITLE II — The Truckee–Carson–Pyramid Lake Water Rights Settlement Act*. Collectively, the legislation can be referred to as the *Negotiated Settlement*. The seven (7) main elements covered by the legislation include:

- [1] **Promote the Enhancement and Recovery of Endangered and Threatened Fish Species** — A recovery program is to be developed for the Pyramid Lake endangered fish species cui-ui (*Chasmistes cujus*) and the threatened fish species Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) in compliance with the *Endangered Species Act (ESA)* and the Truckee–Carson–Pyramid Lake Water Rights Settlement Act. Water rights acquisitions are authorized for this purpose.
- [2] **Protect Wetlands from Further Degradation** — A water rights purchase program is authorized for *Lahontan Valley Wetlands*, with the intent of sustaining an average of 25,000 acres of wetlands (*Stillwater National Wildlife Refuge*: 14,000 acres; Carson Lake and Pasture: 10,200 acres; and Fallon Reservation and Indian Lakes: 800 acres) to both prevent further degradation and improve the habitat of the fish and wildlife which depend on those wetlands. The *U.S. Fish and Wildlife Service (USFWS)* has estimated that this will require up to 125,000 acre-feet (AF) of water per year.
- [3] **Encourage the Development of Solutions for Demands on Truckee River Waters** — An operating agreement is to be negotiated for the Truckee River — *The Truckee River Operating Agreement (TROA)* — covering procedures for using storage capacity in upstream reservoirs in California consistent with recovery objectives for listed Pyramid Lake fishes. This includes the implementation of the terms and conditions of the *Primary Settlement Agreement (PSA)* between SPPCo and the Pyramid Lake Paiute Tribe.
- [4] **Improve Management and Efficiency of the Newlands Project** — The Secretary of the Interior is authorized to

operate and maintain the *Newlands Project* to serve additional purposes, including recreation, improved water quality flowing to the wetlands, improved fish and wildlife habitat, and municipal water supply for Lyon and Churchill counties. A project efficiency study is required. The 1973 Gesell Decision is recognized and the 1988 *Operating Criteria and Procedures (OCAP)* is to remain in effect at least through 1997.

- [5] **Fallon Paiute-Shoshone Water Issues Settlement** – Establishment of a settlement fund for the Fallon Paiute-Shoshone Tribe totaling \$43 million. The Tribe is authorized to purchase land and water rights to consolidate tribal holdings within the reservation. Specific litigation filed by the Tribe is to be dismissed.
- [6] **Pyramid Lake Paiute Tribe Issues Settlement** – A tribal economic development fund of \$40 million was established for the Pyramid Lake Paiute Indian Tribe to provide for the settlement of water, fish, and other issues. Another fund of \$25 million was established for the Pyramid Lake fishery.
- [7] **Interstate Water Apportionment Settlement** – Facilitate an interstate allocation of the waters of the Truckee River, Carson River, and Lake Tahoe between the states of California and Nevada.

Also see *Truckee River Agreement [Nevada and California]*.

Public Recreation Areas — Typically means campgrounds, parks, roadside rest areas, and other publicly owned recreation areas that are open to the public and golf courses that are open to the public.

Public Scoping — The process of soliciting public comments on the issues to be examined in environmental documents such as an *Environmental Impact Statement (EIS)* or water planning documents. The process can be carried out by public meetings, soliciting written comments, or both. The identification of issues, alternatives, impacts, mitigation and/or monitoring all may be addressed during the scoping process.

Public Service — The business of supplying an essential commodity, such as water or electricity, or a service, such as communications or transportation, to the public.

Public-Service Corporation — A corporation providing essential services, such as water or electricity, to the public.

Public-Supply Water — (1) Water withdrawn for all users by public and private water suppliers and delivered to users that do not supply their own water. (2) Water withdrawn by and delivered to a public water system regardless of the use made of the water. Includes water supplied both by large municipal systems and by smaller quasi-municipal or privately-owned water companies. Water suppliers provide water for a variety of uses, such as *Domestic Water Use* (also referred to as *Residential Water Use*), *Commercial Water Use*, *Industrial Water Use*, *Thermoelectric Power Water Use* (domestic and cooling purposes), and *Public Water Use*.

Public Trust Doctrine — (1) A vaguely defined judicial doctrine under which the state holds its navigable waters and underlying beds in trust for the public and is required or authorized to protect the public interest in such waters. All water rights issued by the state are subject to the overriding interest of the public and the exercise of the public trust by state administrative and regulatory agencies. (2) Based in Roman Law, the public trust doctrine holds that certain resources belong to all the people and are therefore held in trust by the state for future generations. Since the 1970's, court rulings have expanded the concept of public trust to protect not only the traditional uses of navigation, commerce, and fishing, but also ecological preservation, open space maintenance, and scenic and wildlife habitat preservation. In a 1983 landmark ruling by the California Supreme Court (*National Audubon Society v. Superior Court of Alpine County*), the court found that the state retains jurisdiction over these water rights and may reconsider their impact on the public trust resources, which includes, in addition to navigation, commerce, and fishing, also wildlife habitat. The court concluded that reconsideration and curtailment of longstanding water rights were authorized if necessary to protect the public trust, including the water rights of tributaries of navigable waters. This was to be determined by balancing the value and costs of instream water needs against the benefits and costs of diversions. More specifically, the court held that water right licenses held by the City of Los Angeles and its Department of Water and Power to divert water from streams tributary to Mono Lake remain subject to ongoing State of California supervision under the public trust doctrine and could be curtailed or revoked, if necessary, to protect the public trust. The court held that public trust uses must be considered and balanced when the rights to divert water away from *Navigable* bodies of water are to be considered. Therefore, in issuing or reconsidering any rights to appropriate or divert water, the state must balance public trust needs with the needs for other beneficial uses of water. The foundation for this landmark decision was actually based on a previous 1971 ruling by the California Supreme Court (*Marks v. Whitney*) which broadened the definition of public trust because "public trust uses are sufficiently flexible to encompass changing public needs." Also see *Equal Footing Doctrine (U.S. Constitution)* and *Public Interest, or Public Welfare*.

Public Trust Doctrine [California] — Under the provisions of the public trust doctrine adopted by California, the State Lands Commission (SLC) is the trustee of more than four million acres of state-owned rivers, streams, sloughs, lakes, tidal bays, marshes, and beaches throughout the state. The public trust doctrine holds that certain resources belong to the public. The state, as a sovereign, takes title to tidelands and the beds of non-tidal navigable waters and is charged with managing these lands for the benefit of all state residents. State ownership also extends to the rivers' banks and includes riparian habitat areas as well. Under an historic California Supreme Court decision in 1983 (*National Audubon Society v. Superior Court of Alpine County*), the doctrine was extended to protect recreational, scenic, and environmental values. It also was extended to the tributaries of navigable waters, such as the small streams that drain into Mono Lake. As state trustee the SLC has begun a comprehensive assessment of California's water resources to gather information from which policy decisions could be fabricated. Also see *River Assessment*.

Public Utility — A private business organization, subject to government regulation, that provides an essential commodity or service, such as water, electricity, transportation, or communications, to the public.

Public Water Supply Well — A well that supplies water to one or more of the following: (1) Water distribution systems; (2) Community water systems; (3) Water supplied from other than a common water distribution system to the public from such

facilities as campgrounds, tourist attractions, roadside parks, rest areas, churches, hospitals, nursing homes, schools, or eating, drinking, lodging, and other commercial business establishments or for commercial use or for manufacturing or industrial operations; and (4) Non-community water systems

Public Water System (PWS) — (1) A system for the provision to the public of piped water for human consumption. If such system has at least fifteen service connections or regularly serves at least 25 people at least 60 days out of the year. Such term includes: (a) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system, and (b) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. (2) A system for provision to the public of piped water for human consumption, if such system has at least 15 service connections (such as households, businesses, or schools) or regularly serves at least 25 individuals daily for at least 60 days out of the year. Public water systems are divided into three categories:

- [1] **Community Water Systems** – serves the same population year round (e.g., homes, mobile homes, housing subdivisions);
- [2] **Nontransient-Noncommunity Water Systems** – regularly serves at least 25 of the same people for at least six months of the year (e.g., schools, factories, and hospitals); and
- [3] **Transient Noncommunity Water Systems** – caters to transitory customers in nonresidential areas (e.g., campgrounds, motels, and gas stations).

The terms include any collection, treatment, storage, and distribution facilities under control of the operator of such systems and used primarily in connection with the system, and any collection or pretreatment storage facilities not under such control that are used primarily in connection with the system. As of 1993 there were about 200,000 public water systems in the United States regulated under the *Safe Drinking Water Act (SDWA)*. These systems served approximately 243 million U.S. residents, or 94 percent of the total population of 258 million. The remainder of the population is served by private wells not subject to regulation under the SDWA. Also see *Water Contaminants, Water Treatment Disinfectants, Water Treatment Processes, Water Treatment Technologies, Water Quality Threats, and Waterborne Diseases*.

Public Water Use — Water supplied from a *Public Water Supply System (PWSS)* and used for such purposes as fire fighting, street washing, and municipal parks, golf courses, and swimming pools. Public water use also includes system water losses (water lost to leakage) and brine water discharged from desalination facilities. Also referred to as *Utility Water Use*.

Publicly-Owned Treatment Works (POTW) — (Wastewater Treatment) (1) Facilities for the treatment of domestic sewage that are owned and operated by a public body, usually a municipal government, a state, or Indian tribe. (2) A treatment works which is owned by a state, municipality, city, town, special sewer district or other publicly owned and financed entity as opposed to a privately (industrial) owned treatment facility. This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage (wastewater) or industrial wastes of a liquid nature. It also includes sewers, pipes and other conveyances only if they carry wastewater to a POTW treatment plant. The term also means the municipality (public entity) which has jurisdiction over the indirect discharges to and the discharges from such a treatment works. (Definition adapted from *U.S. Environmental Protection Agency's (EPA) General Pretreatment Regulations*, 40 CFR 403.3.)

Pudding Ball — See *Armored Mud Ball*.

Puddle — (1) A small pool of water usually a few inches deep and from several inches to several feet across. (2) An accumulation of meltwater on ice due to melting snow or ice. (3) The act of compacting earth, soil, clay, etc. by mixing them with water and rolling or tamping the mixture. (4) A compact mass of earth, soil, clay, or mixture of one or more, which has been compacted through the addition of water and rolling and tamping, and has been made more or less impervious.

Puddling — The compaction of wet material, such as clay, in order to make a watertight paste.

Pueblo (Water) Right — (Southwest United States) A water right possess by a municipality which, as a successor a Spanish-law pueblo, is entitled to the beneficial use of all needed, naturally occurring surface and groundwater of the original pueblo watershed.

Pueblo (Water) Rights [California] — In addition to Riparian Water Rights and Appropriative Water Rights, California also recognizes pueblo water rights. Under this doctrine, cities that are successors of Spanish or Mexican pueblos, and have followed claim procedures establishing their pueblo rights, possess a paramount right to the beneficial use of all needed, naturally occurring surface and subsurface water from the entire watershed of the stream flowing through the original pueblo. Under this system, water use must occur within the modern city limits, and excess water may not be sold outside the city. The quantity of water available for use under a pueblo right increases with population and with extensions and annexations of the city's boundaries. In general, pueblo water rights related to the use of water for ordinary municipal purposes, domestic use, stock watering, and irrigation purposes. The only restriction is that the use be both reasonable and beneficial.

Pump — (1) A device which moves, compresses, or alters the pressure of a fluid, such as water or air, being conveyed through a natural or artificial channel. (2) Equipment installed at ground surface or in a well which delivers water from an aquifer or storage unit.

Pump (Head) Curve — The relationship between the head developed by a pump and the capacity (flow) for a constant rotative speed.

Pump Lift — The distance between the groundwater table and the overlying land surface.

Pump Station — (Wastewater Treatment) Installation of pumps to lift wastewater to a higher elevation in places where flat land would require excessively deep sewer trenches. Also used to raise wastewater from areas too low to drain into available collection lines. These stations may be equipped with air operated ejectors or centrifugal pumps. See *Lift Station*.

Pumped Hydroelectric Storage — Storing water for future use in generating electricity. Excess electrical energy produced during a period of low demand is used to pump water up to a reservoir. When demand is high, the water is released to operate a

hydroelectric generator.

Pumped Storage — (1) A reservoir that has a pumping plant as the main source of water supply. (2) Water pumped upgrade into a reservoir or lake during periods of low electric power consumption. The water added to the reservoir is later released through the hydroelectric facility to generate electricity during times of high power demand.

Pumped Storage Plant — A hydroelectric power plant which generates electric energy for peak load use by utilizing water pumped into a storage reservoir during off-peak periods.

Pumped Storage Project — A hydroelectric power plant and reservoir system using an arrangement whereby water released for generating energy during peak load periods is stored and pumped back into the upper reservoir, usually during periods of reduced power demand.

Pumping-Generating Plant — A plant at which the turbine-driven generators can also be used as motor-driven pumps.

Pumping Head — Energy given to a fluid by a pump; usually expressed in feet of fluid (foot-pounds per pound).

Pumping Station — Mechanical devices installed in sewer or water systems or other liquid-carrying pipelines to move the liquids to a higher level.

(Water) Pumping Tax — See *Replenishment Assessment (RA)*.

Pumping Test — A test that is conducted to determine aquifer or well characteristics. More specifically, a test made by pumping a well for a period of time and observing the change in *Hydraulic Head* in the aquifer. A pump test may be used to determine the capacity of the well and the hydraulic characteristics of the aquifer. Also referred to as *Aquifer Test*.

Pumping Water Level — The vertical distance in feet from the centerline of the pump discharge to the level of the free pool while water is being drawn from the pool.

Purge — To force a gas through a water sample to liberate volatile chemicals or other gases from the water so their level can be measured.

Purgeable Organics — Volatile organic chemicals which can be forced out of the water sample with relative ease through purging.

Purification (Water) — Steps taken to eliminate impurities and pollution from water.

Purification Process (Water) — The sequence of steps taken, beginning with unpurified water, which results in purified water delivered through a water system to the ultimate consumer. This sequence would normally include most or all of the following:

- [1] The process begins with unpurified water;
- [2] Screening – removal of leaves, sticks and large foreign material;
- [3] Pre-Chlorination – removal of disease organisms, bad taste, and odors;
- [4] Pre-Settling – settling out large dirt particles;
- [5] Flash Mix – a process in which chemicals are added to cause fine dirt to clump together;
- [6] Coagulation/Flocculation – a process in which flash mix particles are gathered and made even larger;
- [7] Sedimentation – a process in which gravity is used to settle out the large particles formed in coagulation and flocculation;
- [8] Filtration – removal of any remaining particles; water is at least 99 percent particle-free at this point in the process;
- [9] Final Chlorination – removal of any remaining disease organisms and adds necessary chlorine to prevent microbe regrowth in the distribution system;
- [10] Corrosion Control – a step in which chemicals are added to neutralize the corrosive effects of “soft” water systems, thereby preventing damage to plumbing and fixtures;
- [11] Finally, effluent pumps send the purified water to residential, commercial, and industrial establishments.

Purify (Water) — To rid water of impurities or pollution. See Purification Process (Water).

Purl — (1) To flow or ripple with a murmuring sound. (2) The sound made by rippling water. (3) A swirling or eddying stream or rivulet that rapidly moves around obstructions. (4) A popular term for any stream that makes a soft, murmuring sound.

Purveyor — Another name for groundwater producer or pumper.

Putrefaction — The biological decomposition of organic matter by bacteria, fungi, and oxidation, resulting in the formation of foul-smelling products, typically of swamps, bogs, and other areas of persistent moisture; a rotting. A biological process most closely associated with *Anaerobic* conditions.

PWS — See *Public Water System*.

Pyramid Lake [Nevada] — A desert lake located at the terminus of the Truckee River in western Nevada. Pyramid Lake, as well as being the low point of the Truckee River Basin, was also the low point of the ancient Ice Age *Lake Lahontan*, which covered some 8,655 square miles of northwestern Nevada during the late *Pleistocene Epoch* as recently as 12,500 years ago. At its peak surface elevation of 4,380 feet above mean sea level (MSL), Lake Lahontan’s waters extended up the Truckee River to Lagomarsino Canyon near the present-day community of Lockwood, located approximately three miles from downtown Reno, Nevada. Core samples taken of Pyramid Lake’s lake bottom do not indicate a brine concentration, therefore suggesting that throughout Lake Lahontan’s existence, Pyramid Lake remained in existence, although it was periodically severely restricted in size. Pyramid Lake, which is wholly contained within the Pyramid Lake Paiute Indian Reservation, is 30 miles long and ranges from 4 to 11 miles wide and covers approximately 169 square miles (108,000 acres) at a surface elevation of 3,800 feet MSL. At this surface elevation, Pyramid Lake has a maximum depth of 335 feet and contains approximately 21 million acre-feet of water. Situated in Nevada’s arid desert, Pyramid Lake experiences extreme lake surface evaporation, which totals approximately 440,000 acre-feet per year, equivalent to approximately 4.2 feet per year. Pyramid Lake lies within the Pyramid Lake drainage basin, which has a total surface area of 672 square miles (430,080 acres). (Inflows) Pyramid lake has only one surface water inflow, that being the Truckee River, which flows out of *Lake Tahoe* located in the Sierra Nevada. Since the early 1900’s, the decline in Pyramid Lake’s surface elevation has been extreme. For example, the maximum surface elevation for Pyramid Lake

was recorded in September 1891 at 3,878.2 feet MSL, while the minimum surface elevation was recorded during February and March of 1967 at 3,783.9 feet MSL, representing a maximum decline in Pyramid Lake's surface elevation in recent times of 94.3 feet. Along with this decline in Pyramid Lake's surface elevation has come an even more significant decline in the lake's total volume, resulting in increased *Total Dissolved Solids (TDS)*, or salinity concentrations which now stand at approximately 5,100 milligrams per liter (mg/l, or parts per million, ppm). Based on Pyramid Lake's extreme level of evaporation and limited surface water inflows from the Truckee River, the lake has, on the average, experienced a water budget deficit, i.e., surface evaporation has exceeded all inflows, since the early 1900's. As long as this water budget deficit continues to exist, the lake will continue to shrink and TDS concentrations will continue to increase. (Fishery) The long-term degradation of the water quality of Pyramid Lake, along with warmer water temperatures in the lower Truckee River due to both reduced river flows below Derby Dam and increased discharges from the Truckee Meadows Water Reclamation Facility (TMWRF) serving Reno and Sparks, Nevada, have combined to degrade the water quality in the lower Truckee River and jeopardize Pyramid Lake's continued existence as a viable fishery. The restricted Truckee River flows into Pyramid Lake since diversions for the *Newlands Irrigation Project* began in 1905 have been a contributing factor in the extinction of the Pyramid Lake cutthroat trout in the early 1940's. Pyramid Lake is presently the home of the endangered cui-ui fish species (*Chasmistes cujus*), a bottom sucker found only in this lake, and the threatened Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*). The Lahontan cutthroat trout species was introduced into Pyramid Lake in the early 1950's after the native sub-species, the Pyramid Lake cutthroat trout became extinct. The survival of these two fish species has become a crucial issue with respect to upstream storage (Stampede Reservoir on the Little Truckee River and Prosser Reservoir on Prosser Creek). Other major issues affecting the quantity and quality of Pyramid Lake's water inflows include maintaining river flows sufficient for endangered and threatened fish spawning runs, continued upstream diversions, particularly at Derby Dam and the transfer of Truckee River waters to the Carson River for the *Newlands Irrigation Project*, and the right of the Pyramid Lake Paiute Indian Tribe to unallocated flood waters in the Truckee River.

Pyrite — A mineral, FeS_2 , commonly called fool's gold because of its brassy yellow color. The iron sulfide minerals, mainly pyrite and marcasite, are the minerals which break down chemically and form mine acids. See *Acid Mine Drainage*.

Q

Quagmire — (Ecology) An area of wet or swampy ground.

Quaking Bog — (Geology) (1) A water-saturated or floating *Peat Bog* that is unstable when walked upon. (2) A *Bog* formed of *Peat*, wholly or partially floating, so that it shakes when trodden upon. Also see *Peatland*.

Qualitative — Descriptive of kind, type or direction, as opposed to size, magnitude or degree.

Qualitative Analysis — (Data Analysis) The examination or analysis of a phenomenon to determine its qualitative characteristics versus its quantitative characteristics, i.e., characteristics for which precise numerical identification are not appropriate. Contrast with *Quantitative Analysis*.

Quality of Snow — (Meteorology) The amount of ice in a snow sample, expressed as a percentage of the weight of the sample.

Quantification (Water) — Defining the amount and timing of a *Water Right*.

Quantitative — Descriptive of size, magnitude, or degree.

Quantitative Analysis — (Data Analysis) The examination of phenomena using actual observed data with an intention to explain historical behavior and/or predict the future behavior of some phenomenon. Contrast with *Qualitative Analysis*. Also see *Model*, (*Econometric*) *Model Building*, *Regression*, *Regression Analysis*, *Ordinary Least Squares (OLS)*, *Classical Linear Regression (CLR) Model*, and (*Inherently*) *Linear Model*.

Quantitative Geomorphology — (Geology) A mathematical analysis of the descriptive parameters of landform geometry and geomorphic processes.

Quantitative Precipitation Forecast (QPF) — A forecast of the amount of precipitation which will fall during a specific time period. These precipitation amount forecast values can then be used as inputs to hydrologic models for river forecasting purposes.

Quart — A measure of capacity in both liquid and dry measure equal to two pints. The U.S. liquid quart is $\frac{1}{4}$ the gallon of 231 cubic inches; The U.S. dry quart is $\frac{1}{32}$ the bushel of 2,150.42 cubic inches, or $\frac{1}{8}$ peck. The British quart, adopted in 1824, equals 2 pints or $\frac{1}{4}$ the imperial gallon, is used for both liquid and dry commodities and equals 1.0320 U.S. dry quarts or 1.2009 U.S. liquid quarts. Prior to 1824 various quarts were in use for different commodities. Also see *Gallon [Imperial]* and *Gallon [U.S.]*.

Quarter-Flow Interval — The shortest period of time in days (typically) during which one-quarter of the annual runoff occurs.

Quartz — (Geology) The most common rock-forming mineral. It is made up of silicon dioxide (SiO_2). Quartz crystals may be glassy or opaque (milky quartz) and exist in a variety of colors including white, rose, smoky gray, and purple.

Quartzite — (Geology) A hard *Metamorphic Rock* made up of interlocking quartz grains that have been cemented by silica.

Quasi-Equilibrium — (Geology) In a stream cross section, a condition of balance or grade in which a state of near equilibrium tends to occur in a reach of the stream contemporaneously with the establishment of a relatively smooth longitudinal profile.

Quasi-Hydrostatic Approximation — (Meteorology) The application of the *Hydrostatic Equation* as the vertical equation of motion, resulting in the inference that the vertical accelerations are small without constraining them to be zero.

Quaternary Period — (Geology) A period consisting of approximately the last 2 million years of earth history, encompassing both the *Pleistocene* and the *Holocene* epochs.

Quench — (1) To slake one's thirst. (2) To cool (hot metal) by thrusting into water or other liquid.

Quench Tank — A water-filled tank used to cool incinerator residues or hot materials during industrial processing.

Quenched Water — (Oceanography) An area of turbulent water in which air bubbles absorb and scatter sound waves, decreasing the efficiency of sound propagation through the water and interfering with sonar technology.

Quick — (Geology) (1) Describing a sediment that becomes soft or loose when mixed with water and flows easily under a load or gravitational force. (2) Describing a soil in which a decrease in inter-granular pressure causes the water to flow upward, significantly reducing the soil's bearing capacity. (3) Describing a highly porous soil with a tendency to absorb heat readily. Also see *Quick Condition*.

Quick Condition — A condition of soil in which an increase in pore-water pressure decreases particle-to-particle attraction and reduces significantly the soil's bearing capacity.

Quicklime — (1) Another term for lime, or calcium oxide (CaO), used in many water and wastewater treatment operations such as softening, coagulation, and phosphorus removal. (2) A material that is mostly calcium oxide (CaO) or calcium oxide in natural association with a lesser amount of magnesium oxide. Quicklime is capable of combining with water to form hydrated lime. Also see *Hydrated Lime*.

Quicksand — (1) Sand that is unstable due to the upward pressure of water. (2) Sand which becomes semi-liquid or easily moveable when it is soaked with an excess of water. (3) Sand that has lost its grain to grain contact by the buoyancy effect of water flowing upward through the voids. Such material, having some of the characteristics of a fluid, possesses no load bearing value. (4) Sand easily moved or readily yielding to pressure, especially a deep mass of loose sand mixed with water, very dangerous from the difficulty of extricating anything that begins sinking into it. (5) (Geology) A mass or thick bed of fine sand made up of smooth, loose grains, generally saturated with upward-flowing water, resulting in a soft, semiliquid, highly mobile and unstable mass that yields under pressure and that readily swallows heavy objects touching its surface. Also referred to as *Running Sand*.

R

R² (Coefficient of Determination) — (Statistics) A measure of the fraction of the variance of the *Dependent*, or *Endogenous Variable* explained by the *Independent*, or *Exogenous Variable(s)*. Where only two variables are involved, i.e., the dependent variable and a single independent variable, the coefficient of determination (R²) is also equal to the square of the *Correlation Coefficient*.

RAA — See *Running Annual Average*.

Race — (1) A strong or swift current of water. (2) The channel of such a current. Also, an artificial channel built to transport water and use its energy; a *Raceway*. (3) (Oceanography) A very rapid current, or the narrow channel through which it flows.

Raceway — A rectangular fish rearing unit that has a continuous flow of freshwater to maintain suitable oxygen, temperature, and cleanliness for intensive production.

Radial Drainage — An arrangement of stream courses in which the streams radiate outward in all directions from a central zone or inward from all directions to a central area.

Radial Drainage Pattern — A pattern of natural stream courses in which the streams diverge outward from a high central area. Also referred to as a *Centrifugal Drainage Pattern*.

Radial Flow — The flow of water in an aquifer toward a vertically oriented well.

Radial to Impeller — Perpendicular to the impeller shaft. Material being pumped flows at a right angle to the impeller.

Radiation Fog — A type of fog produced over land when radiative cooling reduces the air temperature to or below its dew point.

Radioactive Chemicals — See *Radiochemicals*.

Radioactive Waste — Equipment and materials (from nuclear operations) which are radioactive and for which there is no further use. Wastes are generally classified as high-level (having radioactivity concentrations of hundreds to thousands of curies per gallon or cubic foot), low-level (on the order of 1 microcurie per gallon or cubic foot), or intermediate (between these ranges).

Radiocarbon (Carbon-14) — A radioactive isotope of carbon with an atomic weight of 14, which is produced by collisions between neutrons and atmospheric nitrogen. It is useful in radiometric age determinations of carbonaceous material up to a maximum age of about 50,000 years.

Radiocarbon Dating — The determination of the age of objects of plant or animal origin by measurement of the radioactivity of their radiocarbon content. See *Radiocarbon*.

Radiochemicals — Also referred to as radioactive chemicals, radiochemicals occur in natural waters. Naturally radioactive ores are particularly common in the Southwestern United States, and some streams and wells can have dangerously high levels of radioactivity. Total alpha and beta radioactivity and isotopes of radium and strontium are the major tests performed for radiochemicals. The federal drinking water standard for gross alpha radioactivity is set at 5 picocuries per liter.

Radioisotope — Isotopic forms of an element that exhibit radioactivity. Isotopes are varieties of a chemical element that differ in atomic weight, but are very nearly alike in chemical properties. The difference arises because the atoms of the isotopic forms of an element differ in the number of neutrons in the nucleus. For example, ordinary chlorine is a mixture of isotopes having atomic weights of 35 and 37, and the natural mixture has an atomic weight of about 35.543. Many of the elements similarly exist as mixtures of isotopes, and a great many new isotopes have been produced in the operation of nuclear devices such as the cyclotron. There are 275 isotopes of the 81 stable elements, in addition to more than 800 radioactive isotopes.

Radionuclides — (1) Any man-made or natural element which emits radiation in the form of alpha or beta particles, or as gamma rays. (2) Radioactive chemicals that are usually naturally occurring and found in drinking water. Typical radionuclides for which the *U.S. Environmental Protection Agency (EPA)* has established *Maximum Contaminant Levels (MCLs)* as part of its enforcement of the *Safe Drinking Water Act (SDWA)* include radium 226 and 228, gross alpha particle activity, and beta particle activity.

Radius of Influence — The radial distance from the center of a well bore to the point where there is no lowering of the water table or *Potentiometric Surface* (the edge of its *Cone of Depression*).

Radon — A radioactive element, chemical symbol Rn, atomic number 86, and atomic weight 222 (Radon-222). Radon is a colorless, tasteless, odorless, naturally-occurring inert gas derived from the natural breakdown (i.e., radioactive decay) of three radioactive isotopes: uranium-238, uranium-235, and thorium-232. These isotopes are typically found in igneous and metamorphic rocks, such as granite and gneiss, and in sedimentary rocks such as organic-rich black shale, phosphatic rock, and coal. Uranium-238 is the most common parent of radon gas because it comprises more than 99 percent of uranium and thorium isotopes found on earth. Radon-222, one of the most common radioactive daughter elements of uranium-238 decay has a relatively short half-life of only 3.8 days. Consequently, radon-222 is relatively unstable and more likely to decay and emit radiation at any particular moment. Daughter isotopes of radon-222 have an even shorter half-life, resulting in a cascade or "burst" of radiation from radon and its daughter products. Radon occurs in groundwater, but not in surface water due to its high volatility. In groundwater, radon will stay in solution until the pressure on the groundwater is decreased. Due to its short half-life and the slow rate of natural groundwater flow, radon in groundwater typically cannot migrate far from its source. Radon is relatively easy to remove from water; several effective options for the treatment of radon in water include storage, adsorption

on *Granular Activated Carbon (GAC)*, and aeration. It has been proposed that radon provides about one-half of the radiation to which the average American is exposed. The chemically inert gas enters homes through soil, water, and building materials. The threat is not uniformly distributed across the United States. An important source of personal exposure to radon appears to be drinking water obtained from wells. The threat comes from the inhalation of the gas released from water during showering, bathing, cooking, and other water uses. Ingestion of water does not appear to present a threat.

Raft — An accumulation or jam of floating logs or debris formed naturally in a stream.

Raft Lake — A temporary body of water that is confined along a stream by an accumulation of floating logs or other debris.

Rafted Ice — (Oceanography) The most extreme stage of pressure ice, characterized by ice floes stacked on one another. Also referred to as *Raft Ice*.

Rafting — A deformation of floating ice in which one floe overrides another, as a result of extreme pressure in an ice pack.

Rain — (1) The liquid form of precipitation. (2) Water falling to earth in drops that have been condensed from moisture in the atmosphere. Generally larger than 0.02 inches (0.05 cm) in diameter and which fall in still air at velocities usually greater than 10 feet (3.0 meters) per second.

Rain Area — (1) The area indicated on a weather map over which rain fell within a certain period of time. (2) The area over which rain is falling. (3) The most rainy portion of a cyclonic storm.

Rain Barrel — A barrel of, or for rain water, particularly a barrel placed so as to catch water dripping from eaves of a house or other buildings.

Rain Cast — See *Rain Print*.

Rain Cloud — (Meteorology) A *Cloud* of any type from which rain falls.

Rain Crust — A snow crust that is characterized by a dimpled surface, formed when surface snow is melted or dampened by rain and then re-freezes.

Rain Erosion — (Ecology) The transfer of material down a hillslope as a result of rainfall; normally consisting of rain splash, which is the detachment and down-slope transfer of small soil particles by raindrop impact, and soil wash, to include the down-slope movement of material by surface water flow.

Rain Forest (or Rainforest) — (Ecology) (1) An area characterized by tall, broad-leaved, densely growing, primarily evergreen trees and a moist climate, having a dry season that is brief or absent; commonly found in the tropics, subtropics, and some sections of the temperate zone. (2) A tropical woodland that has an annual rainfall of at least 100 inches (254 centimeters) and often much more, typically restricted to certain lowland areas. Also see *Tropical Rain Forest* and *Temperate Rain Forest*.

Rain Gauge (also Rain Gage) — An instrument for catching and measuring the depth of rainfall. There are various kinds and sizes of rain gages, most of which catch the rainfall in a collector or cross-sectional area larger than that of the measuring compartment, so that a given depth of water in the latter represents a considerably smaller depth of rainfall catch. Also referred to as an *Ombrometer*.

Rain, Heavy — Rain which, at the time of observation, is falling with an intensity in excess of 0.30 inches (0.76 cm) per hour (over 0.03 inches [0.08 cm] in 6 minutes). Also see *Precipitation*.

Rain, Light — Rain which, at the time of observation, is falling with an intensity of between a trace and 0.10 inches (0.25 cm) per hour (0.01 inches [0.03 cm] in 6 minutes). Also see *Precipitation*.

Rain, Moderate — Rain which, at the time of observation, is falling with an intensity of between 0.10 inches (0.25 cm) per hour (0.01 inches [0.03 cm] in 6 minutes) and 0.30 inches (0.76 cm) per hour (0.03 inches [0.08 cm] in 6 minutes). Also see *Precipitation*.

Rain, Net — The portion of rainfall which reaches a stream channel or concentration point as direct surface flow.

Rain Pillar — (Geology) An upward-projecting column of soil or soft rock that is capped and protected by pebbles or concretions, formed by differential erosion caused by falling rain.

Rain Print — (Geology) A small, shallow, circular pit with a slightly raised rim, formed by the impact of a raindrop falling in soft sand, clay, or mud. Also referred to as *Rain Cast*, *Raindrop Imprint*, or *Raindrop Impression*.

Rain Sensor — A simple, relatively inexpensive device that measures rainfall and prevents unnecessary irrigation with an automatic controller.

Rain Shadow — (1) A dry region on the lee side of a topographic barrier, usually a mountain range, where the rainfall is noticeably less than on the windward side. (2) (Meteorology) The geographical region on the lee side of a mountain or mountain range that receives less precipitation than the windward side.

Rain Shadow Desert — (Ecology) A section of arid land lying in a rain shadow. Also referred to as *Orographic Desert*.

Rain Splash — (Agronomy) The movement of soil particles by the impact of rain; a cause of erosion.

Rain Stage — (Meteorology) An ideal thermodynamic process of water condensation from moist air that rises without heat transfer at temperatures above the freezing point; this stage begins at the condensation level.

Rain Track — (Meteorology) Any visible pattern that consistently reflects higher than normal rainfall in a given area.

Rainband — (Physics and Meteorology) A dark band in the yellow portion of the solar spectrum near the sodium lines, caused by watery vapor in the atmosphere, and hence sometimes used in weather predictions.

Rainbow — (Meteorology) A circular bow or arc exhibiting, in concentric bands of light, the several colors of the spectrum, and formed opposite the sun by the refraction and reflection of the sun's rays in drops of rain. Also, a similar arc may be formed by the moon, or some other source of light, or one formed in spray mist, fog, clouds, etc. Rainbows are circular because the drops, being spherical, are alike in every position. In the case of the ordinary rainbow, or *Primary Rainbow*, the effective rays are refracted on entering each drop, reflected from its interior surface and refracted again on emerging, then passing to the observer's eye. The red is seen on the outside edge of the bow. Also, there is often seen another larger bow, the *Secondary Rainbow*, concentric with and near the first. Its formation differs from that of the primary rainbow in that there are two internal reflections,

it is much fainter, and it has the red on the inside edge. Faint-colored arcs sometimes seen next to the primary or secondary bow, due to interference, are *Supernumerary*, or *Spurious, Rainbows*. *White Rainbows* are sometimes formed by fog or clouds, but are too minute to give distinctly the concentric bands of color of the ordinary rainbow.

Raindrop — (Meteorology) (1) A drop of rain. (2) An elliptical or spherical drop of water with a diameter greater than 0.5 mm that falls from a cloud through the atmosphere.

Raindrop Impression (or Raindrop Imprint) — See *Rain Print*.

Rainfall — (Meteorology) (1) A shower or fall of rain. (2) The quantity of water that falls as rain only in a specified area and time interval. (3) The amount of precipitation of any kind, especially the amount that is measured by a rain gauge, taking into account a small amount of direct condensation. Not strictly synonymous with *Precipitation*.

Rainfall Component — That part of the flow of a channel attributed to rain falling directly on the surface of the channel.

Rainfall Duration — The period of time during which rainfall occurs, exceeds a given intensity, or maintains a given intensity.

Rainfall, Excess — That part of the rain in a given storm which falls at intensities exceeding the *Infiltration Capacity* of the land. The volume of rainfall available for direct runoff. It is equal to the total rainfall minus *Interception*, *Depression Storage*, and *Absorption*.

Rainfall, Excessive — Rainfall in which the rate of fall is greater than certain adopted limits, chosen with regard to the normal precipitation (excluding snow) of a given place or area. Within the United States, according to the *National Weather Service (NWS)*, it is defined, for states along the southern Atlantic coast and the Gulf coast, as rainfall in which the depth of precipitation is 0.90 inch at the end of 30 minutes and 1.50 inches at the end of one hour, and for the rest of the country as rainfall in which the depth of precipitation at the end of each of the same periods is 0.50 and 0.80 inch, respectively.

Rainfall Frequency — (Meteorology) (1) The frequency, usually expressed in years, at which a given rainfall intensity and duration can be expected to be equaled or exceeded. (2) The number of times during a specified number of years that precipitation of a certain magnitude occurs, or is predicted to occur, at a given weather station.

Rainfall (Precipitation) Intensity Area Curve — A curve which expresses the relation between average rainfall or precipitation depth (or the rate) and the area over which it occurs for a given storm duration. Each curve generally covers a period of years during which the intensities shown will not, on the average, be exceeded more than once.

Rainfall (Precipitation) Intensity-Duration Curve — A curve showing the relationship between average rainfall or precipitation depth (or the rate) and storm duration in a given area.

Rainfall (Precipitation) Intensity-Duration-frequency Curve — Curves showing the relationship between rainfall or precipitation intensity and duration for different levels of frequency; each curve represents the rainfall intensity-duration which will be equaled or exceeded once in a certain number of years, indicated as the frequency of that curve.

Rainfall (Precipitation) Intensity Frequency — The average time interval between the occurrence of the rainfall or precipitation of a given or greater intensity.

Rainfall, Maximization — (1) *Moisture Maximization* — The process of adjusting precipitation upward to a theoretical value that would have pertained if the moisture content of the air had been at the maximum with other storm conditions remaining unchanged. (2) *Sequential Maximization* — Reducing the observed elapsed time between storms to develop a hypothetical severe precipitation sequence. (3) *Spatial Maximization* — Reducing the distance between precipitation storms for a hypothetical severe sequence.

Rainfall Penetration — The depth to which water from a particular rainfall has been able to infiltrate the surface of the soil.

Rainfall Rate — The amount of precipitation occurring in a unit of time; generally expressed in inches per hour.

Rainfall Regime — (Meteorology) The character of seasonal rainfall distribution at any place, including equatorial, tropical, monsoonal, oceanic, or continental westerlies, or Mediterranean rainfall.

Rainfall (Precipitation), Residual — Rain (or precipitation) that falls at the end of a storm at a rate less than the infiltration capacity.

Raininess — (Meteorology) (1) In general, the quantitative character of rainfall for a place. (2) An estimate of the amount of precipitation during a given past century, before the beginning of instrumental observations; based on historical records of floods and droughts, as well as the availability of these records.

Rainmaker — (Meteorology) (1) One who is supposedly capable of producing rain. (2) A person who is able or who purports to be able to induce an increased amount of *Rainfall*.

Rainmaking — (Meteorology) A collective term for all activities or artificial methods, both scientific and nonscientific, that are used to increase the amount of precipitation released from a cloud, such as *Cloud Seeding*.

Rainsquall — (Meteorology) A brief weather event in advance of a thunderstorm that arises as a result of a strong convective atmosphere, in which cumulus clouds are present and become the catalyst for a squall of rain blowing outward from the thunderstorm. Also referred to as a *Thundersquall*.

Rainstick — A common term for a type of tubular rattle that mimics the sound of rainfall; a primitive musical instrument in which sound is produced by the movement of particles (sand, stones, etc.) through a hollow tube with an internal matrix that is closed on each end.

Rainwash (or Rain Wash) — (Geology) (1) The washing away or movement of loose soil and other surface material by ground rainwater before the water has been channeled into well-defined streams. (2) The material transported or washed away by rainwater. (3) The rainwater that removes loose surface material in this manner.

Rainwater — (1) Water that has fallen as *Rain* and contains little dissolved mineral matter; surface water that has fallen to the earth as rain, but that does not contain dissolved material from the soil and is thus relatively soft. (3) (Meteorology) Another term for rain.

Rainy Climate — (Meteorology) A climate of abundant rainfall; generally used to describe tree climates, not polar climates.

Rainy Season — (Meteorology) An annually recurring period of one or more months, during which precipitation is at a maximum

for a region; generally used to describe such a period as a primary recurring feature of the tropics and subtropics. Also referred to as *Wet Season*.

Raised Beach — (Geology) A beach that has been elevated above the high-water mark and separated from the present beach by local crustal movements or by the lowering of the sea level.

Raised Bog — (Ecology) An area made up of moist, spongy, usually domed-shaped soil that forms on lake sediments, uniform clay substrates, and occasionally on valley-bog surfaces; commonly found in central Ireland. Also see *Peatland*.

Ram — An underwater projection from an ice wall, iceberg, floe, or ice front, usually caused by melting and erosion of the unsubmerged part. Also referred to as *Apron* or *Spur*.

Ramsar Convention on Wetlands — The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 130 “Contracting Parties” to the Convention, with 1,107 wetland sites, totaling 87.2 million hectares (215.5 million acres, 336,680 square miles, 872,000 square kilometers), designated for inclusion in the Ramsar List of *Wetlands of International Importance*. The Convention’s mission is the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world. At the time of joining the Ramsar Convention on Wetlands, each Contracting Party undertakes to designate at least one site for inclusion in the List of Wetlands of International Importance (the “Ramsar List”). The inclusion of a site in the Ramsar List confers upon it the prestige of international recognition and obliges the government to take all steps necessary to ensure the maintenance of the ecological character of the site. While inscription on the Ramsar List acknowledges the international importance of the site, Article 2.4 of the Convention established that “The inclusion of a wetland in the List does not prejudice the exclusive sovereign rights of the Contracting Party in whose territory the wetland is situated.” At any time, Contracting Parties may designate additional wetlands for the List or extend the boundaries of those already included. They select wetlands within their territories on the basis of their international significance in terms of ecology, botany, zoology, limnology, or hydrology, as measured by reference to the Convention’s Criteria for Identifying Wetlands of International Importance. The information on each listed site is included in the Ramsar Database maintained by Wetlands International under contract with the Ramsar Convention. The “Wise Use Guidelines” of the Ramsar Convention on Wetlands call upon Contracting Parties to:

- [1] Adopt national wetland policies, involving a review of their existing legislation and institutional arrangements to deal with wetland matters (either as separate policy instruments or as part of national environmental action plans, national biodiversity strategies, or other national strategic planning);
- [2] Develop programmes of wetland inventory, monitoring, research, training, education and public awareness; and
- [3] Take action at wetland sites, involving the development of integrated management plans covering every aspect of the wetlands.

The Guidelines emphasize the benefits and values of wetlands for sediment and erosion control; flood control; maintenance of water quality and abatement of pollution; maintenance of surface and underground water supply; support for fisheries, grazing and agriculture; outdoor recreation and education for human society; and climatic stability.

Randkluft — A crevasse at the head of a mountain *Glacier* that separates moving ice and snow from the surrounding wall of the valley when no *Ice Apron* is present.

Random Sample — (Statistics) A sample selected in such a manner that all possible samples of the same size have an equal and independent chance of being included.

Random Variable — (Statistics) A variable characterized by random behavior in assuming its different possible values. Mathematically, it is described by its probability distribution, which specifies the possible values of a random variable together with the probability associated with each value.

Range — (Instrumentation) The spread from minimum to maximum values that an instrument is designed to measure. Also see span and effective range.

Range — (1) Geographic region in which a given plant or animal lives and grows. (2) Lands that support an understory of periodic cover of herbaceous or shrubby plants suitable for grazing. The following represent some common range classifications:

- [1] **Range, Primary** – Includes areas which are readily accessible, have available water and will be overused before livestock significantly graze other areas;
- [2] **Range, Secondary** – Areas less preferred by livestock which will ordinarily not be grazed significantly until the primary range has been overused;
- [3] **Range, Suitable** – Lands that are or can be made accessible to livestock, that produce forage or have inherent forage producing capabilities, and that can be grazed on a sustained yield basis under given management goals;
- [4] **Range, Transitory** – Lands temporarily suitable for grazing, but transient over time and/or location, for example, grass may cover an area for a period before being replaced by growth not suitable for forage;
- [5] **Range, Unsuitable** – Areas that should not be grazed by livestock because of unstable soils, steep topography, or inherent low potential for forage production.

Range Carrying Capacity — Permitted *Animal Unit Month (AUM)* production.

Range Condition — The state of the plant community on a range site in relation to the potential natural plant community for that site. Ratings generally follow categories of poor, fair, good, or excellent.

Range Line — In the generally recognized *U.S. Public Land Survey*, every 24 miles a station is indicated measuring both east and west from a predetermined principal meridian. Similar measurements are also taken north and south from a predetermined base line. In this manner a succession of quadrilaterals are formed, each roughly 24 miles square. Each of these is subdivided into 16 smaller quadrilaterals roughly six miles square. In this system of grid lines, north-south lines become *Range Lines* and east-

west lines become *Township Lines*.

Rankine Scale — A scale of absolute temperature using *Fahrenheit* degrees, in which the freezing point of water is 491.69E and the boiling point of water is 671.69E. [Named after William John Macquorn Rankine (1820–1872), Scottish engineer and physicist.]

Ranney Collector — This water collector is constructed as a dug well from 12 to 16 feet (3.5 to 5 m) in diameter that has been sunk as a caisson near the bank of a river or lake. Screens are driven radially and approximately horizontally from this well into the sand and the gravel deposits underlying the river.

Rapid — A fast, turbulent stretch of river, often with obstructions, but usually without an actual waterfall. Also *Rapids*.

Rapid Bioassessment Protocols (RBP) — The processes and procedures for conducting biological (periphyton, benthic macroinvertebrates, fish) and habitat investigations for determining the aquatic integrity (relative condition) of streams and rivers.

Rapid Drawdown — Lowering the elevation of water against a bank faster than the bank can drain, leaving a pressure imbalance that may cause the bank to fail.

Rapid Sand Filter — Generally a concrete basin filled with graded gravel and coarse sand. Filtration rates are about 40 times higher than in a slow sand filter, and cleaning is via a backwash operation.

Rapids — (1) A part of a stream or river in which the current moves significantly faster than usual, as from a narrowing or steepening of the channel or the presence of obstructions; it does not have the definite break in slope of a waterfall. (2) A swift, turbulent current flowing through such an area. (1) A part of a stream or river in which the current moves significantly faster than usual, as from a narrowing or steepening of the channel or the presence of obstructions; it does not have the definite break in slope of a waterfall. (2) A swift, turbulent current flowing through such an area. (3) A part of a stream where the current is moving with a greater swiftness than usual and where the water surface is broken by obstructions, but without a sufficient break in slope to form a water fall, as where the water descends over a series of small steps. It commonly results from a sudden steepening of the stream gradient, from the presence of a restricted channel, or from the unequal resistance of the successive rocks traversed by the stream.

Rapture of the Deep — A state of euphoria and exhilaration that occurs when nitrogen in normal air enters the bloodstream at approximately seven times atmospheric pressure (as in deep-water diving). Also called *Nitrogen Narcosis*.

Rare Species — A species of plant or animal which, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens.

RAS — See *Return Activated Sludge*.

Rate Structures (Water and Wastewater Treatment) — Rate structures for water and wastewater treatment are generally classified into three primary categories: declining block, uniform, and inverted. Details of these primary rate structures are as follows:

- [1] **Declining Block Rate** — Provides a means of recovering costs from the customer classes under a single rate schedule, recognizing the different water and wastewater demands and costs associated with each customer class. Under this rate schedule economies of scale are recognized since the price per unit declines as the water customer consumes more water;
- [2] **Uniform Rate** — Provides separate rates for each customer class based on the demand, use, and other characteristics of the customer class;
- [3] **Inverted-Block Rate** — Incorporates a unit charge that increases with increasing water consumption or demands for wastewater treatment; requires a multiple blocking structure with the rate per unit of consumption increasing with each successive level.

Variations and applications of these primary rate structures typically include:

- [1] **Unmeasured Usage** — Flat rate, irrespective of usage, generally based on (pipe) size of service;
- [2] **Constant Block with Service Charge** — Constant rate per unit, times the number of units consumed, plus flat rate service charge;
- [3] **Increasing Block with Service Charge** — Cost per unit increases with increasing (block) rate of water usage, plus flat rate service charge;
- [4] **Decreasing Block with Service Charge** — Cost per unit decreases with increasing (block) rate of water usage, plus flat rate service charge;
- [5] **Increasing Block with Minimum Allowance** — Cost per unit increases with increasing (block) rate of water usage over a minimum charge for minimum amount of use (*Lifeline Rate*).

Rating Curve — (1) A graphic representation of a *Rating Table* (see below). (2) A curve showing the relation between *Gage Height* and discharge of a stream or conduit at a given *Gaging Station*. (3) A curve showing the relation between the discharge of a gage, meter, or other hydraulic structure or instrument and the pertinent hydraulic conditions affecting the discharge, such as pressure, hydrostatic head, and velocity of approach. If more than one condition affects discharge, a family of curves is needed to represent the rating. See *Stage-Discharge Curve*.

Rating Table — (1) A table showing the relation between two mutually dependent quantities or variables over a given range of magnitude. (2) A table showing the relation between the *Gage Height* and the discharge of a stream or conduit at a given *Gaging Station*. (3) A table showing the relationship between the stage in a reservoir and its volume. Also referred to as *Discharge Table*.

Rational Formula — An equation used to calculate the maximum rate of discharge from a particular drainage basin, equal to the product of the rate of rainfall, the area of the drainage basin, and a runoff coefficient that depends on the characteristics of the particular basin.

Rational Method (or Formula) — (1) A simple procedure for calculating the direct precipitation peak runoff from a watershed, using the rainfall intensity, the area of the watershed, and the runoff coefficient appropriate for the type of watershed runoff

surface. (2) A technique for estimating peak discharge rates based on average rainfall intensity (i), the drainage area (A), and a coefficient based on watershed characteristics (C). The discharge in cubic feet per second is derived from the following formula: $Q = CiA$. The rational method is commonly applied to areas as large as 5 square miles, but is preferably used for drainage areas under a half square mile. The 2-, 5-, 10-, 25-, and 50-year flood recurrence discharges can be estimated with this formula.

Rates of Rise and Fall — How rapidly the elevation of the water rises and falls during a flood.

Ravine — (1) A deep, narrow valley or gorge in the earth's surface worn by running water. (2) A small narrow steep-sided valley that is larger than a gully and smaller than a canyon and that is usually worn by running water.

Raw Sewage — Untreated domestic or commercial wastewater.

Raw Sludge — The material settled out during the primary clarification of sewage.

Raw Water — (1) Water that is direct from the source – ground or surface water – without any treatment. (2) Untreated water, usually that entering the first unit of a water treatment plant.

RBP — See *Rapid Bioassessment Protocols*.

RCRA — See *Resource Conservation and Recovery Act*.

RCRA Regulated Units [EPA] — Surface impoundments, waste piles, land treatment units, and landfills that received hazardous waste after July 26, 1982, and are subject to subject to *Resource Conservation and Recovery Act (RCRA)* monitoring and corrective action.

Reach (of River) — (1) Most generally, any specified length of a stream, channel, or conveyance. (2) A length of channel which is uniform in its discharge depth, area, and slope; a relatively homogeneous length of stream having a similar sequence of characteristics. (3) A length of channel for which a single gage affords a satisfactory measure of the stage and discharge. (4) The length of a river between two gaging stations.

Readily Water-Soluble Substances — In water pollution, chemicals that are soluble in water at a concentration equal to or greater than one milligram per liter (mg/l).

Reaeration — (1) Absorption of oxygen into water from the atmosphere. The rate of reaeration is proportional to the oxygen deficit. (2) The introduction of air through forced air diffusers into the lower layers of the reservoir. As the air bubbles form and rise through the water, oxygen from the air dissolves into the water and replenishes the dissolved oxygen. The rising bubbles also cause the lower waters to rise to the surface where oxygen from the atmosphere is transferred to the water. This is sometimes called surface reaeration.

Reaeration (of Streams) — The natural process by which flowing stream water is mixed with the atmosphere, resulting in the addition of *Dissolved Oxygen* to the water.

Reagent — A pure chemical substance that is used to make new products or is used in chemical tests to measure, detect, or examine other substances.

Real Fluid Flow — (Fluid Mechanics) A flow that takes into consideration the energy lost by the flowing fluid through friction with the boundaries restricting the fluid's motion; real fluid flow in a piping system, for example, would take into consideration the fluid head loss due to the fluid friction encountered in the piping elements.

Reasonable and Beneficial Use [California] — A requirement in the California State Constitution (Article X, Section 2) that all water resources must be put to beneficial use, preventing waste or unreasonable use or unreasonable methods of use.

Reasonable Domestic (Household) Use — The use of a specified amount of water per day as necessary for domestic purposes, with normally a maximum pumping rate specified in gallons per minute or gallons per day. Typically, such uses do not require a water permit or appropriation process.

Reasonable Pump Lift — A determination of the rate and volume of water to be pumped from an aquifer. The reasonable pump lift (rate of withdrawal) would include consideration of:

- [1] water quality in the aquifer or the basin, including sea water intrusion, base of fresh water, and lateral or vertical migration of contaminants;
- [2] the groundwater management program;
- [3] the thickness of the aquifer;
- [4] the depth of existing wells;
- [5] the capital cost of new wells;
- [6] the net cash flow; and
- [7] the total amount of groundwater that can be extracted during one water year by the total number of existing wells.

Reasonable Use — A rule with regard to percolating or riparian water restricting the landowner to a reasonable use of his own rights and property in view of and qualified by the similar rights of others, and the condition that such use not injure others in the enjoyment of their rights.

Reasonable Use Doctrine (Theory) — The doctrine, theory, or concept that states that a *Riparian Owner* may make reasonable use of his water for either natural or artificial wants. However, he may not so use his rights so as to affect or jeopardize the quantity or quality of water available to a lower riparian owner. Also see *Correlative Water Rights*.

Réaumur, or Reaumur (R) — Relating to, being, or indicated on a thermometer scale that registers the freezing point of water as 0E and the boiling point a 80E. Named after René Antoine Ferchault de Réaumur.

Recalcitrant — Of a substance that is degraded at an extremely slow rate if at all when released into the environment. Consequently, this type of material tends to accumulate in water, soil, and biota.

Recarbonation (Recarbonization) — (Water Quality) A process in which carbon dioxide is bubbled into the water being treated to lower the pH. The pH may also be lowered by the addition of acid. Recarbonation is the final stage in the lime-soda ash

softening process. This process converts carbonate ions to bicarbonate ions and stabilizes the solution against the precipitation of carbonate compounds.

Receiver — A device which indicates the result of a measurement. Most receivers in the water utility field use either a fixed scale and movable indicator (pointer) such as pressure gage or a movable scale and movable indicator like those used on a circular-flow recording chart. Also called an indicator.

Receiving Waters — (1) All distinct bodies of water that receive runoff or wastewater discharges, such as streams, rivers, ponds, lakes, and estuaries. (2) (Water Quality) Bodies of water that receive treated or untreated effluent discharges.

Receptor — (1) In biochemistry: a specialized molecule in a cell that binds a specific chemical with high specificity and high affinity. (2) In exposure assessment: an organism that receives, may receive, or has received environmental exposure to a chemical.

Recession — (1) A decrease in the length or overall volume of a glacier, usually as the result of melting. Also referred to as *Retreat*, *Glacial Retreat*, or *Glacial Recession*. (2) The gradual retreat of a waterfall upstream as in the *Head Cutting* of a stream. (Geology) (3) A backward movement or retreat of a cliff or steep slope as it undergoes a process of weathering or erosion. (4) The landward movement of a shoreline or beach undergoing erosion. Also referred to as *Retrogression*. (5) The withdrawal of a body of water that exposes formerly submerged areas and produces a movement of the shoreline away from higher land.

Recession Curve — See *Recession Hydrograph (Curve)*.

Recession Hydrograph (Curve) — A *Hydrograph* which shows the decreasing rate of runoff following a period of rain or snowmelt. Since *Direct Runoff* and *Base Runoff* recede at different rates, separate curves, called direct runoff recession curves, are generally drawn. Use of the term *Depletion Curve* in the sense of base runoff recession is not recommended.

Recessional Moraine — (Geology) (1) A ridge-like accumulation of glacial drift deposited during a temporary halt in the final retreat of a glacier or during a slight re-advance during a period of general recession. (2) *Glacial Till* occurring as ridges where the front of a retreating glacier temporarily held a fixed position. Also referred to as *Peripheral Moraine* or *Stadial Moraine*. Also see *Moraines*, *Lateral Moraines*, and *Terminal Moraines*.

Recharge — (1) The process by which water is absorbed and added to the zone of saturation, thus replenishing it. (2) The physical process where water naturally percolates or sinks into a *Groundwater Basin*. (3) The amount of water so added. Also referred to as *Increment* or *Intake*.

Recharge (Hydrologic) — (1) The downward movement of water through soil to groundwater. (2) Process by which rain water (precipitation) seeps into the groundwater system. The process by which water is added to the *Zone of Saturation*. (3) The introduction of surface or groundwater to groundwater storage such as an aquifer. Recharge or replenishment of groundwater supplies consists of three types:

- [1] **Natural Recharge** which consists of precipitation or other natural surface flows making their way into groundwater supplies;
- [2] **Artificial or Induced Recharge** which includes actions by man specifically designed to increase supplies in a groundwater reservoirs through various methods such as water spreading (flooding), ditches, and pumping techniques; and
- [3] **Incidental Recharge** which consists of actions, such as irrigation and water diversion, which add to groundwater supplies but are intended for other purposes.

Recharge may also refer to the amount of water so added.

Recharge Area — Any area where absorbed water eventually reaches one or more *Aquifers* in the *Zone of Saturation*. Also referred to as *Intake Area*.

Recharge Area (Groundwater) — (1) The land area over which precipitation infiltrates into soil and percolates downward to replenish an aquifer. (2) Area in which water reaches the ground-water reservoir by surface infiltration. An area in which there is a downward component of hydraulic head in the aquifer. (3) The area in which water reaches the *Zone of Saturation* by surface infiltration. Infiltration moves downward into the deeper parts of an aquifer in a recharge area. Also referred to as a *Recharge Zone*.

Recharge, Artificial — The designed (as opposed to the natural or incidental) replenishment of groundwater storage from surface water supplies. There exist five (5) common techniques to effect artificial recharge of a groundwater basin:

- [1] **Water Spreading** consisting of the basin method, stream-channel method, ditch method, and flooding method, all of which tend to divert surface water supplies to effect underground infiltration;
- [2] **Recharge Pits** designed to take advantage of permeable soil or rock formations;
- [3] **Recharge Wells** which work directly opposite of pumping wells although have limited scope and are better used for deep, confined aquifers;
- [4] **Induced Recharge** which results from pumping wells near surface supplies thereby inducing higher discharge towards the well; and
- [5] **Wastewater Disposal** which includes the use of secondary treatment wastewater in combination with spreading techniques, recharge pits, and recharge wells to reintroduce the water to deep aquifers thereby both increasing the available groundwater supply and also further improving the quality of the wastewater.

Also referred to as *Induced Recharge*. Also see *Natural Recharge*, *Incidental Recharge*, *Injection*, and *Perennial Yield*.

Recharge Basin — A surface facility, often a large pond, used to increase the infiltration of surface water into a *Groundwater Basin*.

Recharge Boundary — An aquifer system boundary that adds water to the aquifer. Streams and lakes are typical recharge boundaries.

Recharge, Incidental — Groundwater recharge (infiltration) that occurs as a result of human activities unrelated to a recharge

project, for example, irrigation and water diversion (unlined canals). Also see *Artificial (or Induced) Recharge*, *Natural Recharge*, and *Perennial Yield*.

Recharge, Induced — See *Artificial Recharge*, above. Also see *Injection*.

Recharge, Natural — The replenishment of groundwater storage from naturally-occurring surface water supplies such as precipitation and stream flows. Also see *Artificial (or Induced) Recharge*, *Incidental Recharge*, and *Perennial Yield*.

Recharge Rate — The quantity of water per unit of time that replenishes or refills an aquifer.

Recharge Well — (1) A well used to artificially restore one or more aquifers by pumping water into them. Also referred to as *Injection Well*. (2) Used in conjunction with artificial or induced groundwater recharge techniques, the recharge well works directly opposite of pumping wells to induce surface water into the groundwater system. Based on the nature of the soil and rock being recharged, the use of recharge wells typically have limited scope and are better employed for recharging deep, confined aquifers. Also see *Injection*.

Recharge Zone — A land area into which water can infiltrate into an *Aquifer* relatively easily. The infiltration replenishes the aquifer. The location is also referred to as a *Recharge Area*.

Recirculated Water — Water that is used more than one time before it passes back into the natural hydrological system or discharged into a wastewater system. Also referred to as *Recycled Water*.

Recirculation — Water reused within a plant unit. Sometimes, it also means water discharged by one unit and reused by other units in the same plant.

Reclaim — (Ecology) Specifically, to restore wasteland, desert, submerged land, or other previously unusable land to a condition where it can be used as an agricultural site, a wildlife habitat, or for some other desired purpose. Also see *Reclamation*.

Reclamation — (1) The act or process of reclaiming or converting a resource to another use, as swamp or desert lands to irrigable lands or urban lands. (2) The reclaiming of waste, desert, marshy, or submerged land for cultivation, preservation, reuse, etc. (3) The act or process of restoring to cultivation or other use land that has been mined. (4) The recovery of coal or ore from a mine, or part of a mine, that has been abandoned because of fire, water, or other cause.

(United States) Reclamation Act of 1902 — An act passed by Congress on June 17, 1902 which created the *U.S. Reclamation Service* (USRS, renamed the *U.S. Bureau of Reclamation*, USBR, in 1923) as a separate entity within the U.S. Department of the Interior (USDI), apart from the *U.S. Geological Survey (USGS)*. This act committed the federal government to construct irrigation projects in the West and reclaim arid lands for cultivation and settlement. The Truckee–Carson Irrigation Project, located in the lower Carson River Basin in Churchill County, Nevada, became the first reclamation irrigation project completed under this act. In 1919 this project would be renamed the Newlands Project in honor of one of the bill’s sponsors, Nevada’s U.S. Senator Francis G. Newlands. (Note: There had been some question as to whether the Salt River Project in Arizona or the Truckee–Carson Irrigation Project in Nevada was the first federally-approved and federally-funded reclamation project. Actually, the Truckee–Carson Project was one of five projects to be recommended by the Director of the U.S. Reclamation Service. The Truckee–Carson Irrigation Project was authorized on March 14, 1903 and the first water became available on April 1, 1905. The Salt River Project was also authorized on March 14, 1903, construction began August 24, 1903 and the first water became available May 15, 1907, two years after the Truckee–Carson Project began operations.)

Reclamation District — (Legal) A district created by legislation for the purpose of reclaiming swamp, marshy, or desert lands and making them suitable for cultivation or habitation. Usually such districts have power to levy assessments, issue bonds and the like.

Reclamation Drought Index (RDI) — The RDI was developed as a tool for defining drought severity and duration, and for predicting the onset and end of periods of drought. The impetus for the development of the RDI came from the *Reclamation States Drought Assistance Act of 1988*, which allowed states to seek federal drought relief assistance. The RDI is calculated at a river basin level and incorporates the supply components of precipitation, snowpack, streamflow and reservoir storage levels. The RDI differs from the *Surface Water Supply Index (SWSI)* in the incorporation of a temperature component. The RDI is adaptable to a particular region and readily accounts for both climate and water supply factors. RDI classifications include:

Reclamation Drought Index	Drought Condition
4.0 or more	Extremely wet
1.5 to 4.0	Moderately wet
0 to 1.5	Normal to mild wetness
0 to -1.5	Normal to mild drought
-1.5 to -4.0	Moderate drought
-4.0 or less	Extreme drought

Also see *Drought Indexes (Indices)*.

(United States) Reclamation Service — A bureau of the U.S. Department of the Interior, created under the *Reclamation Act of 1902* and organized to reclaim desert lands (chiefly in the West) by irrigation projects for public sale and to develop electric power. The U.S. Reclamation Service changed its name to the Bureau of Reclamation (BOR) in 1923.

Reclaimed Sewage — Wastewater treatment-plant effluent that has been diverted or intercepted for use before it reaches a natural waterway or aquifer.

Reclaimed Waste Water — Waste water that becomes suitable for a specific beneficial use as a result of treatment or brackish water demineralized for use. General types of reclaimed waste water include:

- [1] **Primary Effluent** – Reclaimed water that only has had sewage solids removed and is typically used only for surface irrigation of tree, fodder, and fiber crops;
- [2] **Secondary Effluent** – Reclaimed water that has had sewage solids removed and has been oxidized and disinfected and is used to irrigate golf courses and cemeteries and provide water for pasture and food crops; and
- [3] **Tertiary Recycled Water** – Water produced by conventional sewage treatment followed by more advanced procedures including filtration and disinfection, providing it with the broadest range of uses.

Also see *Waste Water Reclamation* and “*Repurified Water*.”

Reclaimed Water — Refers to water that has received at least *Secondary Wastewater Treatment* and is reused after flowing out of a wastewater treatment facility.

Reclamation — (1) The process of land treatment that minimizes water degradation, air pollution, damage to aquatic or wildlife habitat, flooding, erosion, and other adverse effects from surface mining operations including adverse surface effects incidental to underground mines, so that mine lands are reclaimed to a usable condition which is readily adaptable for alternate land uses and creates no danger to public health or safety. The process may extend to affected land surrounding mining lands, and may require backfilling, grading, resoiling, revegetation, soil compaction, stabilization, and other measures. (2) May also apply to other land uses and land types, for example, the reclaiming of waste, desert, marshy or submerged land for cultivation, preservation, reuse, etc.

Reclamation Act — Refers to the Reclamation Act which was passed by Congress on June 17, 1902 and authorized the U.S. Secretary of the Interior to locate, construct, operate, and maintain facilities for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands in the Western States. To facilitate these functions, in July 1902 the Secretary of the Interior established the U.S. Reclamation Service (USRS) within the U.S. Geological Survey (USGS). In March 1907 the USRS was established as a separate entity apart from the USGS and in June 1923 the name was changed to the U.S. Bureau of Reclamation (USBR). The basic purpose of the Reclamation Act was to assist states and local governments to stabilize and stimulate local and regional economies, enhance and protect the environment, and improve the quality of life through the development of water and related land resources throughout the 17 contiguous western states and Hawaii.

Reclamation District — A subdivision of a state created by legislative authority for the purpose of reclaiming swamp, marshy, or desert lands within its boundaries and rendering them fit for habitation or cultivation, generally with funds raised by local taxation or the issue of bonds, and sometimes with authority to make rules or ordinances for the regulation of the project.

Reclamation Project — (1) A water development project based on the Reclamation Act of 1902 for the irrigation of arid lands, particularly in the western United States, and for other purposes administered by the U.S. Department of the Interior, *Bureau of Reclamation (USBR)*. Also see *Newlands (Irrigation) Project [Nevada]*. (2) A project where water is obtained from a sanitary district or system and which undergoes additional treatment for a variety of uses, including landscape irrigation, industrial uses, and groundwater recharge.

Reclamation of Wastewater — The process of treating salvaged water from municipal, industrial, or agricultural waste water sources for beneficial uses, whether by means of special facilities or through natural processes.

Reclamation Withdrawal — A withdrawal of public lands in connection with a reclamation project.

Recommended Maximum Contaminant Level (RMCL) — The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on human health would occur, and that includes an adequate margin of safety. Recommended levels are nonenforceable health goals. Also see *Maximum Contaminant Level (MCL)*.

Reconditioning (Water Well) — The deepening, reaming, casing, recasing, perforating, reperforating, jetting, swabbing, installing of liner pipe, packers and seals or any other significant change in the design or construction of a water well.

Reconnaissance — A preliminary inspection or survey of an area, such as a forest, range, watershed, or wildlife area, to gain general information useful for future management.

Reconnaissance Report — An initial planning document to determine whether further investigation is warranted.

Reconsequent — See *Resequent*.

Reconsequent Stream — See *Resequent Stream*.

Reconstitute — To bring (a liquid in concentrate or powder form) to normal strength by adding water.

Recorder — A device that creates a permanent record, on a paper chart or magnetic tape, of the changes of some measured variable.

Recorder, Steam Flow — A mechanical apparatus which records a continuous record of a water level or other hydrologic factors such as water temperature, flow rates, etc.

Recording Gage — A *Gage* which provides a continuous recording of the parameter being monitored. For example, see *Stream Gaging*.

Recoverable from Bottom Material — The amount of a given constituent that is in solution after a representative sample of bottom material has been digested by a method (usually using an acid or mixture of acids) that results in dissolution of readily soluble substances. Complete dissolution of all bottom material is not achieved by the digestion treatment and thus the determination represents less than the total amount (that is, less than 95 percent) of the constituent in the sample. To achieve comparability of analytical data, equivalent digestion procedures would be required of all laboratories performing such analyses because different digestion procedures are likely to produce different analytical results.

Recoverable Groundwater — The amount of water which may be physically and economically withdrawn from the groundwater reservoir.

Recovery — (1) A rise in the static water level of a well that occurs when the flow from that well or a nearby well ceases. Also referred to as *Groundwater Recovery*. (2) Any process through which groundwater is removed from a source. Also referred to as *Groundwater Withdrawal*. (3) The amount of groundwater thus removed. (4) (Ecology) The process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term

survival in nature can be ensured.

Recovery Plan — (Ecology) A document which delineates, justifies, and schedules the research and management actions necessary to support recovery of a species, including those that, if successfully undertaken, are likely to permit reclassification or delisting of the species.

Recreation Resource — Land and water areas and their natural attributes, with or without man-made facilities, that provide opportunities for outdoor recreation.

Recreation Visitor Day (RVD) — A recreation visitor day is use of a site or area for 12 visitor-hours, aggregated as 1 person for 12 hours, 12 persons for 1 hour, or any equivalent combination of continuous or intermittent use.

Recreational Benefit — The value of a recreational activity to the recreationist, usually measured in dollars above the cost of participating in the recreational activity (travel, lodging, entrance fees, etc.). Used for valuing recreational resources produced through various water-development projects. A term used synonymously with the consumer surplus associated with the recreational activity.

Recreational Rivers — A classification under the national *Wild and Scenic Rivers Act* to include those rivers or sections of rivers that are readily accessible by road or railroad that may have some development along their shorelines, and that may have undergone some impoundments or diversions in the past:

- [1] **Timber Production** – Timber harvesting would be allowed under standard restrictions to protect the immediate river environment, water quality, scenic, fish and wildlife, or other values.
- [2] **Water Supply** – Existing low dams, diversion works, riprap and other minor structures are allowed providing the waterway remains generally natural in appearances. New structures are prohibited.
- [3] **Hydroelectric Power** – No development of hydroelectric power facilities is provided.
- [4] **Flood Control** – Existing flood control works may be maintained. New structures are prohibited.
- [5] **Mining** – Subject to regulations (i.e., 36 CFR 228) that the Secretaries of Agricultural and Interior may prescribe to protect the values of rivers included in the national system, new mining claims and mineral leases could be allowed and existing operations allowed to continue. However, mineral activity must be conducted in a way that minimizes surface disturbances, sedimentation and pollution, and visual impairment.
- [6] **Road Construction** – Paralleling roads or railroads could be constructed on one or both riverbanks. There can be several bridge crossings and numerous river access points.
- [7] **Agriculture** – Lands may be managed for a full range of agricultural uses, to the extent currently practiced.
- [8] **Recreational Development** – Campgrounds and picnic areas may be established close to the river. However, the recreational classification does not require extensive recreational development.
- [9] **Structures** – Small communities and dispersed or cluster residential development are allowed. New structures are allowed for both habitation and for intensive recreation use.
- [10] **Utilities** – New transmission lines, gas lines, water lines, etc., are discouraged. Where no reasonable alternative exists, additional or new facilities should be restricted to existing right-of-way. Where new rights-of-ways are indicated, the scenic, recreation, and fish and wildlife values must be evaluated in the selection of the site.
- [11] **Motorized Travel** – Motorized travel on land or water may be permitted, prohibited or restricted. Controls will usually be similar to surrounding lands and waters.

Also see *Wild and Scenic Rivers Act*, *Wild Rivers*, and *Scenic Rivers*.

Rectangular Drainage Pattern — A pattern of natural streams and their tributaries that displays many right-angle bends and sections that are approximately equal in length. Also referred to as *Rectangular Pattern* and *Lattice Drainage Pattern*.

Rectangular Pattern — An arrangement of stream courses in which tributaries flow into larger streams at angles approaching 90°.

Rectify — (Chemistry) (1) To refine or purify, especially by distillation. (2) To adjust (the proof of alcoholic beverages) by adding water or other liquids.

Recurrence Interval (Return Period) — (1) A statistical expression of the average time between floods equaling or exceeding a given magnitude. (2) The average time interval, usually in years, between the occurrence of a flood or other hydrologic event of a given magnitude or larger. The reciprocal, or inverse, of the recurrence interval is the probability (chance) of occurrence, in any year, of a flood equaling or exceeding a specified magnitude. For example, a flood that would be equaled or exceeded on the average of once in 100 years would have a recurrence interval of 100 years and a 0.01 probability, or 1 percent chance of occurring or being exceeded in any year. (3) (USGS) The average time, usually expressed in years, between occurrences of hydrologic events of a specified type (such as exceedances of a specified high flow or non-exceedance of a specified low flow). The terms “return period” and “recurrence interval” do not imply regular cyclic occurrence. The actual times between occurrences vary randomly, with most of the times being less than the average and a few being substantially greater than the average. For example, the 100-year flood is the flow rate that is exceeded by the annual maximum peak flow at intervals whose average length is 100 years (that is, once in 100 years, on average); almost two-thirds of all exceedances of the 100-year flood occur less than 100 years after the previous exceedance, half occur less than 70 years after the previous exceedance, and about one-eighth occur more than 200 years after the previous exceedance. Similarly, the 7-day 10-year low flow ($7Q_{10}$) is the flow rate below which the annual minimum 7-day-mean flow dips at intervals whose average length is 10 years (that is, once in 10 years, on average); almost two-thirds of the non-exceedances of the $7Q_{10}$ occur less than 10 years after the previous non-exceedance, half occur less than 7 years after, and about one-eighth occur more than 20 years after the previous non-exceedance. The recurrence interval for annual events is the reciprocal of the annual probability of occurrence. Thus, the 100-year flood has a 1-percent chance of being exceeded by the maximum peak flow in any year, and there is a 10-percent chance in any year that the annual minimum 7-day-mean flow will be less than the $7Q_{10}$.

Recycle — The salvage and reprocessing of used materials (paper, metals, glass, cloth, etc.).

Recycled Water — (1) Water that is used more than one time before it passes back into the natural hydrologic system. (2) Water that is used more than one time by the same users. Also referred to as *Recirculated Water*.

Recycling — (1) (Engineering) Any process of recovering or extracting valuable or useful materials from waste or scrap. (2) (Ecology) The process by which salvaged materials become usable products. Specifically, the reuse of specific consumer or industrial items in order to conserve scarce materials, reduce pollution and littering, and generally improve the condition of the environment. More and more frequently, organized municipal recycling programs recycle various consumer wastes such as aluminum cans, glass and plastic containers, and newsprint or other paper products.

Red Book — (Water Quality) The 1976 publication issued by the U.S. Environmental Protection Agency (EPA), *Quality Criteria for Water*, that is used as a basis for ambient water quality standards.

Red Data Book — A collection of the available information relative to *Endangered and Threatened Species*. Each volume contains colored loose-leaf information sheets arranged by species. The sheets are updated as the status of a species changes. Red sheets are used for those species that are endangered; amber for vulnerable; white for rare; green for out of danger; and gray for species that are indicated to be endangered, vulnerable, or rare, but with insufficient information to be properly classified. The book is maintained by the *International Union for Conservation of Nature and Natural Resources*.

Red Snow — Snow on which red-pigmented algae has grown, commonly found in Arctic and alpine regions. Also referred to as *Pink Snow*.

Red Tides — (Ecology) (1) A visible red-to-orange coloration of the sea caused by the presence of a bloom or excessive growth of dinoflagellates in marine waters, resulting in a red, brown, green or yellow tint in the water. The event causes the death of marine biota and the accumulation of toxins in mussels or clams. Consumption of the toxin-containing shellfish can cause *Paralytic Shellfish Poisoning* or severe gastric distress in humans. (2) A population explosion of certain marine *Dinoflagellates*, occurring especially off the coasts of California and Florida and resulting in a reddish or reddish-brown color of the water. Red tides kill many marine animals and render mollusks extremely toxic to humans because of the water-soluble poisonous alkaloid that the dinoflagellates produce. See *Brown Tides*.

Red Water — See *Red Tide*.

Redd — A type of fish spawning area associated with flowing water and clean gravel. Fishes that utilize this type of spawning area include trout, salmon, some minnows, etc.

Reducing Agent — Any substance, such as base metal (iron) or the sulfide ion (S_2^{2-}), that will readily donate (give up) electrons. The opposite is an *Oxidizing Agent*.

Reduction — Reduction is the addition of hydrogen, removal of oxygen, or the addition of electrons to an element or compound. Under anaerobic conditions (no dissolved oxygen present), sulfur compounds are reduced to odor-producing hydrogen sulfide (H_2S and other compounds). The opposite of *Oxidation*.

Reef — A strip or ridge of rocks, sand, or coral that rises to, or near the surface of a body of water.

Reemergence — See *Resurgence*.

Reference — (Chemistry) A physical or chemical quantity whose value is known exactly, and thus is used to calibrate or standardize instruments.

Reference Condition — The chemical, physical, or biological quality or condition exhibited at either a single site or an aggregation of sites that represent the least impaired or reasonably attainable condition at the least impaired *Reference Sites*.

Reference Site — A site on a waterbody which represents the best attainable physical habitat, water chemistry, and biological parameters for specific environmental conditions.

Reference Wetlands [Corps] — (1) A wetland within a relatively homogeneous biogeographic region that is representative of a specific *Hydrogeomorphic* wetland type. (2) As used in the U.S. Army Corps of Engineers' (Corps) *Hydrogeomorphic Approach* to wetland assessment and classification, these are wetland sites that encompass the variability of a *Regional Wetland Subclass* in a reference domain. Reference wetlands are used to establish the range of conditions for construction and calibration of *Wetland Functional Capacity Indices* and establish reference standards.

Reflectance — The ratio of the upwelling light to incident (downwelling) light. Reflectance is a strong function of wavelength, and a weak function of incident sunlight and the depth in the water. The color of natural waters can be objectively specified using their spectral reflectance. Also see *Water Color*.

Reforestation — (1) The planting of trees on land from which the forest has been removed. (2) The replanting of trees in forests that have been affected by cutting, fire, disease, etc.

Regelation — (1) The fusion of two blocks of ice by pressure. (2) Successive melting under pressure and freezing when pressure is relaxed at the interface of two blocks of ice. (3) A two-stage process in which ice (or any other substance that expands upon freezing) melts under applied pressure, and then the resulting meltwater re-freezes upon the release of that pressure; seen in the flow of glaciers or in the formation of a snowball by pressure.

Regenerated Flow Control — The control of glacial drainage as a result of the modification of morainal features by the re-advance of a *Glacier* whose flow had previously stopped.

Regenerated Glacier — A glacier that begins to re-advance after it had previously stopped flowing. See *Glacier Remanié*.

Regime — (1) In a stream channel, the reaching, over a period of years, of a state of equilibrium between erosion and deposition. (2) The condition of a stream with respect to its average flow rate, determined by measuring the volume of water passing different cross sections in a given period of time. (3) "Regime Theory" is a theory of the formation of channels in material carried by the stream. Used in this sense, the word "regime" applies only to streams that take at least part of their boundaries from their transported load and part of their transported load from their boundaries, carrying out the process at different places and times in any one stream in a balanced or alternating manner that prevents unlimited growth or removal of boundaries. A stream, river,

or canal of this type is called a “regime stream, river, or canal.” A regime channel is said to be “in regime” when it has achieved average equilibrium; that is, the average values of the quantities that constitute regime do not show a definite trend over a considerable period, generally, approximately a decade. In unspecialized use, “regime” and “regimen” are synonymous.

Regimen — (1) The flow characteristics of a stream, such as its volume, velocity, and capacity to transport sediment. (2) The analysis of the total amount of water related to a lake, including losses and gains, over a given period of time. (3) The total amount of water related to a particular drainage basin. Also see *Regimen of a Stream*.

Regimen of a Stream — The system or order characteristic of a stream, i.e., its habits with respect to velocity and volume, form and changes in channel, capacity to transport sediment, and amount of material supplied for transportation. The term is also applied to a stream which has reached an equilibrium between corrosion and deposition or, in other words, to a graded stream.

Regional Response Team (RRT) — An organization under the joint leadership of the *U.S. Environmental Protection Agency (EPA)* and the U.S. Coast Guard that serves as the organizational unit to provide for planning and preparedness activities related to spills or discharges of oil and hazardous substances and for coordination and technical advice during such spills or discharges in each of the 10 federal regions outlined by the EPA.

Regional Wetland Subclass [Corps] — As used in the *U.S. Army Corps of Engineers' (Corps) Hydrogeomorphic Approach* to wetland assessment and classification, these are wetlands within a region that are similar based on hydrogeomorphic classification factors. There may be more than one regional wetland subclass identified within each hydrogeomorphic wetland class depending on the diversity of wetlands in a region, and assessment objectives.

Regional Snowline — The level above which the accumulation of snow is greater than its ablation year after year, as averaged over a large area.

Regolith — (Geology) A general term for the layer of fragmental and unconsolidated rock material that nearly everywhere forms the surface of the land and overlies or covers the bedrock.

Reggradation — The formation of a new longitudinal profile by a graded stream.

Regression — (1) The theory that some rivers have their sources on the rainier sides of mountain ranges and gradually erode their heads backward until the ranges are cut through. (2) (Oceanography) A withdrawal of the sea from the land, sometimes in conjunction with a rising landmass. (3) (Geology) The land area resulting from such withdrawal.

Regression — (Statistics) A statistical method for studying and expressing the change in one *Variable* associated with and dependent upon changes in another related variable or set of variables.

Regression Analysis — (Statistics) Mathematical procedures for attributing the variability of one quantity to changes in one or more other quantities. Often called “line fitting” or “curve fitting” since it produces an equation that can be used to predict the quantity of interest under many conditions. The concept is to attempt to fit a mathematical function to a series of data whereby the square of the error terms measuring the differences between the model estimates and actual observations is minimized, hence the term *Ordinary Least Squares (OLS)* is also used to describe this process. The standard of regression model is generally termed the *Classical Linear Regression (CLR) Model*. The CLR Model has five basic assumptions:

- [1] **Linearity** – The dependent variable, or the variable to be explained or forecasted, can be calculated as a linear function of a specific set of independent, or explanatory variables;
- [2] **Randomness of Disturbance Terms** – The expected value of the disturbance term, that is the term showing the differences between the model’s estimated values and the actual observed values, is zero;
- [3] **Uncorrelated Disturbance Terms** – The disturbance terms all have the same variance and are not correlated with each other (see *Serial Correlation*);
- [4] **Data Conformity** – The observations on the independent variable can be considered fixed in repeated samples, i.e., it is possible to repeat the sample with the same independent variables;
- [5] **Sample Size and Selection** – The number of observations is greater than the number of independent variables and that there are no linear relationships, i.e., no significant correlations, between the independent variables (see *Multicollinearity*).

Regular Program — (FEMA) The phase of the *National Flood Insurance Program (NFIP)* that makes available increased amounts of flood insurance, with new and substantially improved structures being rated on an actuarial or actual risk basis.

Regulated Flow — A surface flow downstream from a dam or other flow control structure.

Regulation (of a Stream) — The artificial manipulation of the flow of a stream.

Regulation Reservoir — A reservoir used in canal and irrigation systems to reduce the mismatch between downstream demands and upstream water supplies in order to maintain a balanced operation.

Regulatory Flood Datum (RFD) — Established plane of reference from which elevation and depth of flooding may be determined for specific locations of the floodplain. It is the *Base Flood* plus a *Freeboard* factor of safety established for each particular area which tends to compensate for the many unknown and incalculable factors that could contribute to greater flood heights than that computed for a base flood.

Regulatory Floodplain — (1) That portion of the floodplain subject to floodplain regulations (usually the floodplain inundated by the one-percent chance flood). (2) Flood hazard area within which a community regulates development, including new construction, the repair of substantially damaged buildings, and substantial improvements to existing buildings. In communities participating in the *National Flood Insurance Program (NFIP)*, the regulatory floodplain must include at least the area inundated by the *Base Flood*, also referred to as the *Special Flood Hazard Area (SFHA)*. Also see *Floodplain*.

Regulatory Floodway — (1) The channel and that portion of the adjacent land area that is required through regulations to pass flood flows without increasing the water surface elevation more than a designated height. (2) As adopted into a community’s floodplain management ordinance, is defined by the *Federal Emergency Management Agency (FEMA)* as the stream channel plus that

portion of the overbanks that must be kept free from encroachment in order to discharge the 1-percent annual chance flood without increasing flood levels by more than 1 foot (some states specify a smaller allowable increase). The intention of the floodway is not to preclude development. Rather, it is intended to assist communities in prudently and soundly managing floodplain development and prevent additional damages to other property owners. The community is responsible for prohibiting encroachments, including fill, new construction, and substantial improvements, within the floodway unless it has been demonstrated through hydrologic and hydraulic analyses that the proposed encroachment will not increase flood levels within the community. In areas that fall within the 1-percent annual chance floodplain, but are outside the floodway (termed the floodway fringe), development will, by definition, cause no more than a 1-foot increase in the 1-percent annual chance water-surface elevation. Floodplain management through the use of the floodway concept is effective because it allows communities to develop in flood-prone areas if they so choose, but limits the future increases of flood hazards to no more than 1 foot.

Rehydrate — To cause (something *Dehydrated*) to take up fluid.

Reimbursable Costs — Those costs associated with a water project that are expected to be recovered, usually from direct beneficiaries, and repaid to the funding entity. Also see *Nonreimbursable Costs*.

Rejected Recharge — Water that reaches the water table, but is then released because a full or overflowing aquifer cannot hold it.

Rejuvenated Stream — A mature stream in which renewed erosional activity restores the stream to a more youthful stage of development. Also referred to as a *Revived Stream*.

Rejuvenated Water — Water that has been returned to the earth's water supply as a result of compaction and metamorphism.

Rejuvenation — (1) The stimulation of a stream, either by uplift or by a drop in sea level, to renew erosive activity. (2) The restoration of youthful vigor in a mature stream. (3) A change in condition of erosion that causes a stream to begin more active erosion and a new cycle.

Relation, Doctrine of — See *Doctrine of Relation [Nevada]*.

Relative Humidity — (Meteorology) (1) The ratio of the actual vapor pressure of the air to the saturation vapor pressure; usually expressed as a percentage. (2) The ratio of the amount of water vapor in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and measures the percentage of saturation. Also referred to as *Humidity*.

Relative Roughness Factor — (Fluid Mechanics) A property of piping material and piping diameter that, along with the Reynolds number of the flow field, permits the estimation of a friction factor.

Release — Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous or toxic chemical or extremely hazardous substance.

Releases [EPA] — According to *U.S. Environmental Protection Agency (EPA)* guidelines, a ny spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous or toxic chemical, or extremely hazardous substance.

Relicensing — The process of renewing a license previously issued by the federal government (commonly involving the Federal Energy Regulatory Commission, FERC) to operate a hydroelectric power plant.

Relict — A landform that has survived decay or disintegration (such as an erosion remnant) or that has been left behind after the disappearance of the greater part of its substance (such as a remnant island).

Relict Glacier — The remains or part of the remains of a larger, older *Glacier*.

Relict Lake — (1) A lake remaining in an area that was once covered by the sea or a larger lake. (2) A lake that has become separated from the sea or another original body of water.

Relict Permafrost — A *Permafrost* that was formed sometime in the past and that still persists in areas in which it could not form in the present.

Reliction — (1) A slow, gradual withdrawal of the water in a lake, stream, or sea that permanently exposes the bottom and leaves it uncovered. (2) The land left so exposed. (3) An increase of the land by the permanent withdrawal or retrocession of the sea or a river. The process of gradual exposure of land by permanent recession of a body of water. The alteration of a boundary line due to the gradual removal of land by a stream serving as the boundary. Also, the land so left uncovered. Also see *Dereliction*.

Reliction, Doctrine of [Nevada] — In a Nevada Supreme Court ruling (*State Engineer v. Cowles Bros.*, 86 Nev. 872, 1964) it was held that the lands so exposed by *Reliction* should belong to the adjoining land owners. This held true even for those lands exposed by the recession of a navigable body of water, whose bed is owned by the State of Nevada (e.g., Winnemucca Lake).

Relief Ratio — The average slope of a drainage basin; the ratio of maximum relief to basin length.

Relief Wells (of a Dam) — A vertical well or borehole, usually downstream of impervious cores, grout curtains, or cutoffs, designed to collect and direct seepage through or under a dam to reduce uplift pressure under or within the dam. A line of such wells forms a relief well curtain. Also referred to as *Drainage Wells*.

Remedial Investigation (RI) — (Environmental) An in-depth study designed to gather data needed to determine the nature and extent of contamination at a Superfund site, establish site cleanup criteria, identify preliminary alternatives for remedial action, and support technical and cost analyses of alternatives. The remedial investigation is usually done with the Feasibility Study (FS). Together they are usually referred to as the "RI/FS".

Remedial Response — (Environmental) Long-term action that stops or substantially reduces a release or threat of a release of hazardous substances that is serious but not an immediate threat to public health.

Remediation — (Environmental) Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a Superfund site.

Remedy Expectations [EPA] — Non-binding requirements that reflect collective experience and are designed to guide in the development and implementation of remediation alternatives. In effect, remedial expectations allow program implementers and facility owner/operators to profit from prior *U.S. Environmental Protection Agency (EPA)* experience and focus resources on the

most plausible remedial alternatives.

Remnant — A remaining part of some larger landform or of a land surface that has been dissected or partially buried.

Remote Sensing — The measurement or acquisition of information of some property of an object or phenomenon by a recording device that is not in physical or intimate contact with the object or phenomenon under study. Also, the utilization at a distance (as from aircraft, spacecraft, satellites, or ships) of any device and its attendant display for gathering information pertinent to the environment, such as measurements of force fields, electromagnetic radiation, infrared sensing, land use, water bodies, etc. Such systems typically employ devices such as cameras, lasers, radio frequency receivers, radar systems, infrared detectors, sonar seismographs, gravimeters, magnetometers, and scintillation counters.

Renewable Energy — A source of energy that is replaced by natural phenomena, such as firewood or the water held by a dam and used for hydroelectric purposes. Conversely, fossil fuels are a nonrenewable source of energy.

Renewable (Natural) Resource — Natural resources that continuously can be replenished in the course of natural events within the limits of human time. Also see *Natural Resource* and *Nonrenewable Natural Resource*.

Renewable Water Supply — The rate of supply of water (volume per unit of time) potentially or theoretically available for use in a region on an essentially permanent basis.

Repeat Compliance Period — Any subsequent compliance period after the initial compliance period representative sample A portion of material or water that is as nearly identical in content and consistency as possible to that in the larger body of material or water being sampled.

Repi — Any lake, pond, or other body of standing water associated with a sink or *Subsidence* of a land surface.

Replenishment — (1) The process by which water is absorbed and added to the *Zone of Saturation*. Also referred to as *Recharge*. (2) The act of replenishing an *Aquifer*, usually through artificial recharge, to offset excess groundwater pumping. (3) (Geology) The stage in the development of a cavern during which the presence of air in the passages allows the formation of mineral deposits by the action of water.

Replenishment Assessment (RA) — Sometimes referred to as a pump tax, the replenishment assessment is a charge on each acre-foot of groundwater extracted from the basin. Income from the RA finances the replenishment of the basin (i.e., *Artificial Recharge*) and projects for water recycling and reuse, conservation, education, and water quality improvements.

Replenishment District — (1) A public agency authorized by the state legislature to secure an adequate water supply to a region. (2) An authority, serving a specific area of water users, which has the ability to combine resources to replenish over drafted aquifers with renewable water supplies.

Replicate Samples — A group of samples collected in a manner such that the samples are thought to be essentially identical in composition.

Representativeness — (Statistics) How well a given sample represents the total population from which it was taken.

Representative Sample — (1) A portion of material or water that is as nearly identical in content and consistency as possible to that in the larger body of material or water being sampled. (2) (Wastewater Treatment) A sample portion of material or wastestream that is as nearly identical in content and consistency as possible to that in the larger body of material or wastestream being sampled.

Repressuring — The injection of water, natural gas, or compressed air to increase the reservoir oil pressure.

“Repurified Water” — Denotes reclaimed or recycled wastewater that is treated far beyond the most stringent standards current in force and then remixed with fresh water to augment existing water supplies. Typically, such waters would undergo extensive *Tertiary Wastewater Treatment* and then be stored in a reservoir (say, for up to one year), subsequently blended with fresh water supplies and then undergo further disinfection through conventional drinking water treatment before being distributed to municipal water users.

Requirement (Water) — Effective demand for water withdrawal.

Re-Regulating Reservoir — A reservoir for reducing diurnal (daily) fluctuations resulting from the operation of an upstream reservoir for power production.

Resedimentation — (Geology) The process of underwater, downslope movement of sediment under the influence of gravity.

Resequent — (Geology) Describing a valley, stream, or drainage system that follows an earlier pattern, but on a newer, lower surface. Also referred to as *Reconsequent*.

Resequent Stream — A stream whose course follows the same direction as an earlier, original stream, but developed later and at a lower level than the original stream. Also referred to as *Reconsequent Stream* or *Renewed Consequent Stream*.

Reservation — A withdrawal usually of a more or less permanent nature; also, any federal lands of the U.S. government which have been dedicated to a specified public purpose such as a national forest, wildlife refuge, or wilderness area.

Reservation Doctrine, Reserved Rights Doctrine, and Winters Doctrine (or Winters Rights) — The legal rule which states that when the United States reserves public lands for a particular purpose it also reserves sufficient water to accomplish that purpose. Those who initiate water rights after the date of the reservation are subject to the reserved right. The doctrine was first announced by the United States Supreme Court in the case of *Winters v. United States*, 207 U.S. 564 (1908), involving a dispute between an Indian reservation and a rancher. For many years it was thought that the doctrine only applied to Indian reservations, but in recent years it has been extended to other types of federal reservations, such as national parks and forests. Also see *Winters Rights (Decision)* and *Practicably Irrigable Acreage (PIA)*.

Reservation or Withdrawal of Water — The withholding of water from appropriation. A reservation or withdrawal of water in order to preserve instream values would have the same affect as a *Minimum Flow Appropriation* for that purpose: The only essential difference is the procedure used.

Reserve Capacity — Extra treatment capacity built into solid waste and wastewater treatment plants and interceptor sewers to accommodate flow increases due to future population growth.

- Reserved Water Rights [Federal]** — A category of federal water rights, created by federal law and recognized by judicial decision. These rights are created when the federal government withdraws land from the public domain to establish a federal reservation such as a national park, forest, or Indian reservation. The reserved water right attaches both to reservations made by presidential executive order and to those made by an act of Congress. By this action, the government is held to have reserved water rights sufficient for the primary purpose for which the land was withdrawn. This class of water rights is a judicial creation derived from a 1908 ruling by the U.S. Supreme Court in *Winters v. United States* (207 U.S. 564, 1907) and subsequent federal case law, which collectively hold that when the federal government withdraws land from general use and reserves it for a specific purpose, the federal government by implication reserves the minimum amount of water unappropriated at the time the land was withdrawn or reserved to accomplish the primary purpose of the reservation. Federal reserved water rights may be claimed when Congress has by statute withdrawn lands from the public domain for a particular federal purpose or where the President has withdrawn lands from the public domain for a particular federal purpose pursuant to congressional authorization. The right to such water is not lost by nonuse, and its priority date is the date the land was set aside. In an important limitation of this doctrine, the Supreme Court also held (*United States v. New Mexico*, 1978) that the doctrine applied only to the extent necessary to accomplish the *primary* purposes for which a land reservation was established. In subsequent rulings further limitations were placed on this doctrine, specifically distinguishing between federal riparian lands that are “reserved lands” and those that are “public domain” lands. Specifically, the Supreme Court ruled that the federal riparian water rights on public domain lands are subordinate to existing appropriate rights. Also see *Winters Rights (Decision)*, *Reservation Doctrine*, *Reserved Rights Doctrine*, and *Winters Doctrine (or Winters Rights)*, and *Water Law [Federal]*.
- Reserves** — Natural resources that can be exploited in an economically feasible manner employing current technology. Compare to *Resources*.
- Reserve Supply** — Developed but presently unused surface water supply available to certain portions of a hydrologic study or planning area (as defined) to meet planned future water needs; the supply is not usually available to other areas needing additional water because of a lack of physical facilities and/or institutional arrangements.
- Reservoir (Water)** — (1) A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water. (2) An artificially created lake in which water is collected and stored for future use. (3) Any natural or artificial storage place from which water may be withdrawn as needed.
- Reservoir Area** — The surface area of a reservoir when filled to controlled retention water level.
- Reservoir, Multipurpose** — A reservoir constructed and equipped to provide storage and release of water for two or more purposes such as flood control, power development, navigation, irrigation, pollution abatement, domestic water supply, etc.
- Reservoir, Re-Regulating** — A reservoir used to regulate the outflow from an upstream reservoir.
- Reservoir, Retarding** — An ungated reservoir for temporary storage of floodwater. Sometimes called a *Detention Reservoir*.
- Reservoir, Single-Purpose** — A reservoir planned to serve only one purpose.
- Reservoir Surface** — The surface of a reservoir at any level.
- Reservoirs** — A natural underground container of liquids, such as oil or water, and gases.
- Residential Water Use** — Water used normally for residential purposes, including household use, personal hygiene, and drinking, watering of domestic animals, and outside uses such as car washing, swimming pools, and for lawns, gardens, trees and shrubs. The water may be obtained from a public supply or may be self supplied. Also referred to as *Domestic Water Use*. Also see *Public Water Supply System* and *Self-Supplied Water*.
- Resident Population** — The number of persons who live within a state or other political subdivision (county, city, etc.) who consider it their permanent place of residence. College students, military personnel, and inmates of penal institutions are counted as permanent residents. According to this definition, tourist and seasonal or part-time residents are considered nonresident population.
- Residual Average Annual Flood Damages** — Those flood damages which are not prevented by a flood control project or by other structural or nonstructural flood damage prevention measures.
- Residual Chlorine** — (1) The amount of free and/or available chlorine remaining after a given contact time under specified conditions. (2) The level of chlorine existing in the distribution system after chlorination at a drinking water treatment plant.
- Residual Depression Storage** — Depression storage existing at the end of a period of excess rain.
- Residual Detention Storage** — Detention storage existing at the end of a period of excess rain.
- Residual Discharge** — Direct surface discharge at the end of a period of excess rain.
- Residual Disinfectant Concentration (“C” in CT Calculations)** — The concentration of disinfectant measured in mg/L in a representative sample of water.
- Residual Drawdown** — The difference between the original static water level and the depth to water at a given instant during the recovery period.
- Residual Flood Damages** — Those flood damages which are not prevented by a flood plain management program. They may or may not be preventable by other flood control measures (including both structural and nonstructural means).
- Residual Mass Diagram** — A diagram or graph plotted with rectangular coordinates, with each ordinate equal to (a) the sum of all preceding quantities in the series up to a given point, minus (b) the arithmetic mean of the series times the number of quantities in the series up to a given point, and the corresponding abscissa representing time, number of the item in the series, etc. A general upward slope of a section of such a graph indicates that the terms in the series within the section are, in general, in excess of the average for the series, and vice versa. The diagram is used in determining cyclic variation of quantities such as precipitation.
- Residual Sodium Carbonate (RSC)** — The excess milliequivalents of carbonate and bicarbonate over the milliequivalents of calcium and magnesium in a sample of water, where:

$$\text{RSC} = (\text{CO}_3^{-2} + \text{HCO}_3^{-2}) - (\text{Ca}^{+2} + \text{Mg}^{+2})$$

where all concentrations are expressed in milliequivalents per liter (meq/l). Waters with RSC values over 2.5 are generally not suitable for irrigation uses.

Residue — The dry solids remaining after the evaporation of a sample of water or sludge. Also see *Total Dissolved Solids (TDS)*.

Residue on Evaporation (ROE) — A procedure for establishing the mineral content of a water.

Residuum — (Geology) Soil material formed from rock weathering in place.

Resilience — The ability of an ecosystem to maintain or restore *Biodiversity*, biotic integrity, and ecological structure and processes following disturbance.

Resistance Coefficient — (Fluid Mechanics) (1) In engineering applications, the resistance coefficient (Λ) is equal to the diameter of a given pipe, divided by the length of pipe in which the pressure decreases by an amount equal to the dynamic pressure corresponding to the mean velocity. (2) In physics literature, however, the resistance coefficient is based on the radius of the pipe. Therefore, the corresponding physics coefficient of resistance (Λ) is half of that used in engineering applications.

Resistivity — The opposite of conductivity of an electrical current passing through fluid-bearing rock formations.

Resolution — The minimum distance between two adjacent features or objects, or the minimum size of a feature or object, that can be detected by a *Remote Sensing* system.

Resource Conservation and Recovery Act (RCRA) [EPA] — Federal legislation requiring that hazardous wastes be tracked from “cradle” (generation) to “grave” (disposal). Enacted in 1980, the RCRA helped ensure that hazardous wastes generated from ongoing industrial operations are properly managed and do not contribute to a future generation of toxic waste sites. Immediately upon enactment, thousands of waste-storage facilities became subject to hazardous waste management regulations. However, many of these facilities had soil and groundwater contamination resulting from their waste management practices prior to 1980. The RCRA Corrective Action Program was intended to address cleanup of past and present contamination at these operating industrial facilities. The RCRA Corrective Action Program is run by both the *U.S. Environmental Protection Agency (EPA)* and individual states, with 38 states and territories authorized to implement the program. Corrective action is conducted under RCRA permits, orders, and other means. The EPA subsequently implement reforms to this program in order to accelerate the cleanup of hazardous waste facilities regulated under the RCRA. EPA’s 1999 reforms promoted faster, focused, more flexible cleanups. The 2001 reforms reinforced and built upon the 1999 reforms and are intended to pilot innovative approaches, accelerate changes in culture, connect communities to cleanup, and capitalize on redevelopment potential, while maintaining protection of human health and the environment. Specifically, the 1999 reforms were designed to:

- [1] Focus the program more effectively on achievement of environmental results, rather than fulfillment of unnecessary steps in a bureaucratic process;
- [2] Foster maximum use of program flexibility and practical approaches to achieve program goals; and
- [3] Enhance public access to cleanup information and improve opportunity for public involvement in the cleanup process.

The RCRA Cleanup Reforms of 2001 highlighted those activities that EPA believed would best accelerate program progress and foster creative solutions. The 2001 reforms reflected the ideas EPA heard from program implementors and stakeholders and introduced new initiatives to reinforce and build upon the 1999 reforms. Specifically, the 2001 reforms are intended to:

- [1] Pilot innovative approaches;
- [2] Accelerate changes in culture;
- [3] Connect communities to cleanups; and
- [4] Capitalize on redevelopment potential.

The RCRA cleanup reforms and designed to foster creative, practical, results-based approaches to corrective actions by:

- Providing tailored oversight while eliminating administrative or technical steps where not needed to assure effective performance;
- Using holistic approaches while evaluating facilities for overall risk and apply appropriate facility-wide corrective action measures;
- Exercising procedural flexibility and emphasizing results over mechanistic process steps and eliminate unproductive activities;
- Setting performance standards which establish clear protective goals and standards the owner/operator must fulfill to complete corrective action; and
- Targeting data collection to facilitate the examination of actual conditions at each facility and to design data requirements as needed to support corrective action decisions.

Resource Management Plan (RMP) — The basic document used by the U.S. Department of the Interior, *Bureau of Land Management (BLM)* to plan the course of management for the use and protection of all public land values, renewable resources, and supporting services.

Resource Management System — A combination of conservation practices identified by the primary use of land or water that, if effected, will at a minimum protect the resource base by meeting tolerable soil losses, maintaining acceptable water quality, and maintaining acceptable ecological and management levels for the selected resource use. Such systems may include conservation practices that provide for quality in the environment and quality in the standard of living.

Resource Monitoring — The act of continually or periodically observing resources to determine changes and trends in their status and condition.

Resources — That which is, or may be, readily available as a source of supply or support. Also, the total amount of any rock, mineral, or fuel in the crust of the earth. Compare to *Reserves*. Also see *Natural Resources*.

(The) Resources Agency [California] — The California Resources Agency (The Resources Agency) is responsible for the conservation, enhancement, and management of California's natural and cultural resources, including land, water, wildlife, parks, minerals and historic sites. The administrative head of The Resources Agency, the Secretary for Resources, is a member of the Governor's Cabinet, serves as the Governor's representative on the Agency's boards and commissions, and oversees administration of the *California Environmental Quality Act (CEQA)*. The agency is composed of departments, boards, conservancies, commissions, and programs as shown below:

[1] **Departments:**

- Department of Boating and Waterways
- Department of Conservation
- Department of Fish and Game
- Department of Forestry and Fire Protection
- Department of Parks and Recreation
- Department of Water Resources
- California Conservation Corps

[2] **Boards and Commissions:**

- California Coastal Commission
- California Energy Commission
- California State Lands Commission
- San Francisco Bay Conservation and Development Commission
- Delta Protection Commission
- Colorado River Board of California
- State Reclamation Board
- Board of Forestry
- Fish and Game Commission
- Mining and Geology Board
- Native American Heritage Commission
- Parks and Recreation Commission
- State Historic Resources Commission
- California Water Commission

[3] **Conservancies:**

- Baldwin Hills Conservancy
- California Tahoe Conservancy
- Coachella Valley Mountains Conservancy
- San Gabriel & Lower Los Angeles
- Rivers & Mountains Conservancy
- San Joaquin River Conservancy
- Santa Monica Mountains Conservancy
- State Coastal Conservancy

[4] **Special Programs:**

- California Biodiversity Council
- California Environmental Resources Evaluation System (CERES)
- California Environmental Quality Act (CEQA) Homepage
- CAL-FED Bay-Delta Program
- California Community Economic Revitalization Team (CERT)
- California Ocean Resources Management Program
- Coastal Resources Grant Program
- Collaborative Programs with U.C. Davis
- Environmental Enhancement and Mitigation Grant Program
- Environmental License Plates
- Mentor Program
- Small Business Liaison

Respiration — (Biology) (1) The process in which an organism uses oxygen for its life processes and gives off carbon dioxide. (2) The oxidative process occurring within living cells by which the chemical energy of organic molecules (i.e., substances containing carbon, hydrogen, and oxygen) is released in a series of metabolic steps involving the consumption of oxygen (O₂) and the liberation of carbon dioxide (CO₂) and water (H₂O).

Response Action — (Environmental) A generic term used to describe actions taken in response to actual or potential health-threatening environmental events such as spills, sudden releases, and similar such events.

Restoration — (1) Re-establishment of wetland and/or other aquatic resource characteristics and function(s) at a site where they have

ceased to exist, or exist in a substantially degraded state. (2) The act or process of bringing something back to a previous condition or position. For example, the establishment of natural land contours and vegetative cover following extensive degradation of the environment caused by activities such as *Surface Mining*. Under this condition, the term is used interchangeably with *Reclamation*.

Resurgence — (1) The place where an underground stream appears at the surface to become a surface stream. Also referred to as a *Rise*, *Rising*, or *Emergence*. (2) The reappearance of a sinking stream from a cave. Also referred to as *Re-Emergence*.

Resurrected — Describing a stream that follows an earlier drainage system after a brief period of submergence has slightly masked the old course with a thin film of sediments.

Resuspended — Describes particles that have been remixed with the air or water from which they have settled. For example, sediment particles will settle from river water if the water is allowed to stand. Those particles may be remixed with the water if turbulent conditions reoccur.

Retained Water — Water that remains in rock or soil after gravity water has drained out.

Retaining Wall — A wall built to support or prevent the advance of a mass of earth or water.

Retarding Reservoir — Ungated reservoir for temporary storage of flood water. Also referred to as a *Detention Reservoir*.

Retention — That part of the precipitation falling on a drainage area which does not escape as surface stream flow during a given period. It is the difference between total precipitation and total runoff during the period, and represents evaporation, transpiration, subsurface leakage, infiltration, and, when short periods are considered, temporary surface or underground storage on the area. The delay or holding of the flow of water and water carried wastes in a pipe system. This can be due to a restriction in the pipe, a stoppage or a dip. Also, the time water is held or stored in a basin or wet well. This is also called *Detention*.

Retention Basin — A permanent lake or pond used to slow stormwater runoff. Also see *Detention Basin*.

Retention Facility — A stormwater storage facility that normally holds water at a controlled level to serve functions such as recreation, aesthetic, and water supply. Stormwater runoff is temporarily stored above the controlled stage. Examples of types of retention storage reservoirs are permanent ponds in residential and commercial areas and in open spaces. Also see *Detention Facility*.

Retention Storage — Water retained in the capillary pores of the soil, not free to move by gravity, and in large part available to plants.

Retention Time — (1) The interval of time that some waste, fluid or other material is in a treatment facility or process unit. (2) (Wastewater Treatment) The time water, sludge or solids are retained or held in a *Clarifier* or *Sedimentation Tank*. See *Detention Time*.

Retrograding Shoreline — (Geology) A shoreline that is being cut back toward the land as a result of wave erosion. Also referred to as *Abrasion Shoreline*.

Return Activated Sludge (RAS) — (Wastewater Treatment) Settled *Activated Sludge* that is collected in the *Secondary Clarifier* and returned to the aeration basin to mix with incoming raw or primary settled wastewater.

Return Flow — (1) The amount of water that reaches a ground or surface water source after release from the point of use and thus becomes available for further use. (2) That part of a diverted flow which is not consumptively used and returns to its original source or another body of water. (3) (Irrigation) Drainage water from irrigated farmlands that re-enters the water system to be used further downstream. Such waters may contain dissolved salts or other materials that have been leached out of the upper layers of the soil. Also see *Consumptive Use* and *Return Flow (Irrigation)*.

Return Flow (Irrigation) — (1) Irrigation water applied to an area which is not consumed in evaporation or transpiration and returns to a surface stream or groundwater aquifer. (2) Water that is applied to a crop but not consumptively used, which makes its way back to a waterway and is available for use by downstream users. (3) Water which reaches surface drainage by overland flow or through groundwater discharge as a result of applied or natural irrigation. (4) Water used for irrigation that is not lost by *Evapotranspiration*, but is returned either to its source or to another body of ground or surface water. Also referred to as *Waste Water* or *Return Water*.

Return Flow Credit — The concept of water use allocations based only on actual *Consumptive Use*; waters returned to the system are credited, in whole or part, against the original allowable allocations.

Return Flow Credit [Nevada] — Nevada's apportionment of Colorado River water is a consumptive use apportionment. Nevada can divert more than its apportionment, however, so long as it returns sufficient Colorado River water to the river such that its net depletion is no greater than the 300,000 acre-feet per year currently allowed. The calculated Colorado River water returned each year is known as "return flow credits". Also see *Colorado River Compact*.

Return Period (or Recurrence Interval) — In statistical analysis of hydrologic data, based on the assumption that observations are equally spaced in time with the interval between two successive observations as a unit of time, the return period is the reciprocal of 1 minus the probability of a value equal to or less than a certain value; it is the mean number of such time units necessary to obtain a value equal to or greater than a certain value one time. For example, with a one-year interval between observations, a return period of 100 years means that, on the average, an event of this magnitude, or greater, is not expected to occur more often than once in 100 years. Also see *Exceedence Interval*, *Recurrence Interval*, *Flood Frequency*, *Frequency Curve*.

Return Seepage — Water which percolates from canals and irrigated areas to underlying strata, raising the ground-water level, and eventually returning to natural channels.

Return Water — See *Return Flow*.

Reuse (of Water) — (1) Water that is discharged by one user and is used by other users. (2) Repeated use of the same water by subsequent users in sequential systems. Sometimes, it also means water discharged by one unit and used by other units in the same plant. Also referred to as *Recycled Water*.

Reuse Systems — Refers to the deliberate application of reclaimed water for a beneficial purpose. Reuse may encompass landscape irrigation (such as golf courses, cemeteries, highway medians, parks, playgrounds, school yards, nurseries, and residential properties), agricultural irrigation (such as food and fruit crops, wholesale nurseries, sod farms and pasture grass), aesthetic uses, ground-water recharge, environmental enhancement of surface water and wetland restoration, fire protection, and other useful purposes.

Reuse Water — Water used repeatedly.

Reversal — A place where the current swings upward and revolves back on itself, forming a treacherous meeting of currents that can drown swimmers and slow, swamp, trap, or flip rafts. Some reversals take the form of flat, foamy, surface back flows immediately below large obstructions just under the surface, while others consist of steep waves that curl heavily back onto their own upstream faces. Reversals are also called *Hydraulics*, *Stoppers*, *Keepers*, *White Eddies*, *Roller Waves*, *Back Rollers*, *Curlers*, *Side Curlers*, *Souse Holes*, and, most frequently, *Holes*. Although some of these terms are used loosely to refer to any sort of reversal, others carry more precise shades of meaning and refer to certain types of reversals.

Reverse Fault — A fault along which the hanging wall has moved up relative to the foot wall.

Reverse Osmosis — (1) A filtration process which forces water through membranes that contain holes so small that even salts cannot pass through. Reverse osmosis removes microorganisms, organic chemicals, and inorganic chemicals, producing very pure water. Reverse osmosis units require regular maintenance or they can become a health hazard. (2) (Desalination) Refers to the process of removing salts from water using a membrane. With reverse osmosis, the product water passes through a fine membrane that the salts are unable to pass through, while the salt waste (brine) is removed and disposed. This process differs from electrodialysis, where the salts are extracted from the feedwater by using a membrane with an electrical current to separate the ions. The positive ions go through one membrane, while the negative ions flow through a different membrane, leaving the end product of freshwater. (3) The application of pressure to a concentrated solution which causes the passage of a liquid from the concentrated solution to a weaker solution across a semipermeable membrane. The membrane allows the passage of the solvent (water) but not the dissolved solids (solutes). The liquid produced is a demineralized water. Also see *Osmosis*. (4) (Water Quality) An advanced method of water or wastewater treatment that relies on a *Semi-permeable Membrane* to separate waters from pollutants. An external force is used to reverse the normal osmotic process resulting in the solvent moving from a solution of higher concentration to one of lower concentration.

Reversed Consequent Stream — A stream whose course follows a direction inconsistent with the slope and configuration of the geologic structure of the area.

Reversed Stream — A stream whose direction of flow has been reversed as a result of glacial action, landsliding, capture, or gradual tilting of the area.

Reversible Effect — An effect which is not permanent, especially adverse effects which diminish when exposure to a toxic chemical is ceased.

Revetment — (1) A facing of stone, bags, blocks, pavement, concrete, or sandbags, or other materials, used to protect a bank of earth from erosion. (2) A retaining wall. (3) A structure built along the coast to prevent erosion and other damage by wave action; similar to a sea wall.

Revetted Levee — An embankment faced with an erosion protection layer, built to prevent a river from overflowing.

Revived Stream — See *Rejuvenated Stream*.

Reynolds Criterion — (Fluid Mechanics) A *Reynolds Number* above which a fluid flow is considered to be turbulent, and below which the flow is considered to be laminar for a given flow condition in a pipe, or over a flat plate; the Reynolds criterion for fluid flowing in a pipe is about 2,100.

Reynolds Equation — (Fluid Mechanics) An equation composed of the characteristic parameters of a particular flow field used to calculate a *Reynolds Number* for that flow field.

Reynolds Number [Re or U] — (Fluid Mechanics) A dimensionless number used as an index of fluid flow characteristics in a pipe, duct, or around an obstacle. The expression for fluid flow in a pipe or duct is equal to:

$$U = (V \times d \times \rho) / \mu$$

where:

V is the fluid velocity;

d is the pipe or duct diameter;

ρ is the fluid density; and

μ is the fluid dynamic viscosity.

For fluid flow around a particle it takes the form:

$$U = (d_p \times v_r \times \rho) / \mu$$

where:

d_p is the particle diameter;

v_r is the velocity of the particle relative to the fluid;

ρ is the fluid density; and

μ is the fluid viscosity.

For fluid flow in a pipe or duct, a Reynolds number below about 2,100 is considered to be streamline, smooth, or *Laminar Flow*;

above 4,000 the flow is turbulent; 2,100–4,000 is a transition zone. For the flow of fluid around a particle, a Reynolds number less than 1.0 is considered laminar flow and as the value increases above 1.0 turbulence increases. The difference between the conditions for laminar flow around particles and in pipes is explained by the impact of inertial forces as the fluid flows around a particle compared to the straight flow in a pipe or duct.

Reynolds Stress — (Fluid Mechanics) An apparent stress that must be added to the stress caused by the mean velocity gradients to make up for the exchange of momentum between adjacent layers of fluid, due to velocity fluctuations in turbulent flow.

Rhabdomancy — Divination by means of a wand or rod, especially for discovering underground water or ores. Also see *Douse (also Dowse)* and *Divining Rod*.

Rheology — The study of the deformation and flow of matter.

Rheophilous — (Ecology) Living or thriving in free-flowing water. Derivative terms include *Rheophile*, *Rheophilic* and *Rheophily*.

Rheophile — (Ecology) An organism that flourishes in free-flowing waterways.

Rheophilous Bog — (Ecology) An area of damp soil made up of organic debris and water that drains in from another source.

Rheophobic — (Ecology) Not tolerant of free-flowing water. Derivative term includes *Rheophobic*.

Rheophyte — (Ecology) A plant that lives or thrives in free-flowing water.

Rheoplankton — (Ecology) Plankton living in flowing water.

Rheotaxis — Movement of an organism in response to a current of water or air.

Rhithron Zone — A stream reach at higher elevations, characterized by rapid flow, low temperature, and high dissolved oxygen levels. Also see *Potamon Zone*.

Rhizodegradation — Rhizodegradation, also called *Enhanced Rhizosphere Biodegradation*, *Phytostimulation*, or *Plant-Assisted Bioremediation/Biodegradation*, is the breakdown of contaminants in the soil through microbial activity that is enhanced by the presence of the *Rhizosphere* and is a much slower process than phytodegradation. Microorganisms (yeast, fungi, or bacteria) consume and digest organic substances for nutrition and energy. Certain microorganisms can digest organic substances such as fuels or solvents that are hazardous to humans and break them down into harmless products through *Biodegradation*. Natural substances released by the plant roots – sugars, alcohols, and acids – contain organic carbon that provides food for soil microorganisms, and the additional nutrients enhance their activity. Biodegradation is also aided by the way plants loosen the soil and transport water to the area. Also see *Phytoremediation*.

Rhizosphere — (Biology) The rhizosphere is the absorbing root-soil interface. It is the zone, about one millimeter in width, surrounding the epidermis of living root hairs and the boundary cells of mycorrhizae as well as hyphae growing out from some mycorrhizae. The rhizoplane is the boundary where soil elements in water are absorbed into the plant. Under an electron microscope, the rhizoplane appears as a jelly where microorganisms and plant cells mix, making it virtually impossible to tell which side is plant and which is soil. A constantly changing mix of organisms inhabit the rhizosphere and surrounding soil. Bacteria, actinomycetes, fungi, protozoa, slime molds, algae, nematodes, enchytraeid worms, earthworms, millipedes, centipedes, insects, mites, snails, small animals and soil viruses compete constantly for water, food, and space. The rhizosphere is a battleground and the wars for survival and dominance are continuous. Amoebae are eating bacteria. Some bacteria are poisoning other bacteria. Fungi are killing other fungi. Nematodes are spearing roots. Fungi are trapping nematodes. Earthworms are eating anything they can find. Sometimes the victors benefit the plant and sometimes they do not. These microorganisms are constantly competing in the rhizosphere, an area rich in exudates from the plant. The exudates contain carbohydrates, organic acids, vitamins, and a number of other substances essential for life. From 5 percent to 40 percent of the total dry matter production of organic carbon from photosynthesis may be released as exudates.

Richness — (Biological) The total number of species in an area, usually expressed as the number of species divided by the total number of individuals, or the number of species per unit area.

Ridge Lines — Points of higher ground that separate two adjacent streams or *Watersheds*. Also referred to as *Divides*.

Ridged Ice — (Oceanography) Rough and irregular pack ice that has been thickened by extensive ridging, the ridges occasionally reaching heights of 30 meters (100 feet) and lengths of 5-6 kilometers (3-4 miles).

Ridgeline Remnant — A narrow ridge with a fully rounded crest that is accordant with the crests of similar nearby ridges. Together these accordant crests approximately mark the position of a preexisting land surface that has been destroyed by dissection.

Riffle — (1) A shallow rapids, usually located at the crossover in a *Meander* of the active channel. (2) Shallow rapids in an open stream, where the water surface is broken into waves by obstructions such as shoals or sandbars wholly or partly submerged beneath the water surface. (3) Also, a stretch of choppy water caused by such a shoal or sandbar; a rapid; a shallow part of the stream. (4) In terms of river rating, a shallow rapid with very small waves, often over a sand or gravel bottom. Does not rate a grade on either the Western or the International scale of difficulty.

Riffle and Pool Complex — Riffle and pool complexes are special aquatic sites under the *Clean Water Act* 404(b)(1) Guidelines. Steep gradient sections of streams are sometimes characterized by riffle and pool complexes. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a coarse substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. Pools are characterized by a slower stream velocity, a streaming flow, a smooth surface, and a finer substrate.

Riffle Pool — A section of stream that has shallow, fast-flowing water followed by deep, slow-flowing water.

Rift — A shallow or rocky place in a stream, forming either a ford or a rapid.

Right — A claim or title to anything that is enforceable by law, such as a right to use water.

Right Abutment — That part of the right-hand side of a valley side wall against which a dam is constructed. The right abutment is viewed by an observer looking downstream.

Right Bank — (1) The right-hand side of a stream, river, or channel when facing in the direction of the flow. (2) Right side of the river when facing downstream. See also *River Right*.

“Right of Free Capture” — The idea or concept that the water under a person’s land belongs to that person and they are free to capture and use as much as they want. Also called the “law of the biggest pump.” Does not apply where both surface water and groundwater are regulated. Also referred to as the “Right of Capture.”

Rill (also Rille) — (1) A small brook; a rivulet. (2) The channel that is eroded by such a stream. (3) A small channel eroded into the soil surface by runoff, rills easily can be smoothed out (obliterated) by normal tillage. (4) A small, intermittent watercourse with steep sides; usually only several centimeters deep; caused by waterborne soil erosion. (Geology) (5) A small, temporary, trough-like hollow that carries wave water from a beach to the sea or a lake, especially following an outgoing tide. (6) A small channel in the wall, floor, or ceiling of a cave that was formed by circulating water. (7) Any small channel resulting from rill erosion.

Rill Erosion — (1) Removal of soil by running water with formation of shallow channels that can be smoothed out completely by normal tillage. (2) Removal of soil particles from a bank slope by surface runoff moving through relatively small channels. The water collecting from these small channels may then concentrate into a larger channel downhill to form the start of a gully. (3) (Geology) The formation of many, minute, closely spaced channels as a result of an uneven removal of surface soil by fine streams of running water. Also referred to as *Rill Wash*, *Rilling*, or *Rillwork*.

Rill Flow — Surface runoff that flows in very small, irregular channels.

Rime — (1) A coating of ice, as on grass and trees, formed when extremely cold water droplets freeze almost instantly on a cold surface. (2) An opaque, granular deposit of ice crystals formed when droplets of supercooled fog come in contact with a vertical surface whose temperature is below freezing. (3) A white and opaque granular deposit of ice formed by the rapid freezing of supercooled liquid water drops as they impinge upon exposed objects. It is denser and harder than hoar frost, but lighter, softer and less transparent than *Glaze*. (4) A white frost of congealed dew or vapor. An accumulation of granular ice tufts on the windward sides of exposed objects, particularly on grass and trees, slightly resembling *Hoarfrost*, but formed only from undercooled fog or cloud and always built out directly against the wind. Also referred to as *Hard Rime*.

Rimy — Covered with *Rime*.

Rip — (1) See *Ripple*. (2) (Oceanography) A turbulent agitation of the water’s surface, usually caused by a conflict between currents, between currents and the wind, or between a strong current and an irregular bottom.

Rip Channel — (Geology) A deep channel cut on the shore by a *Rip Current*.

Rip Current — (Oceanography) (1) A strong, narrow surface current that flows rapidly away from the shore, returning the water carried landward by waves. (2) A seaward flow of water that has been piled up on shore by waves and wind, consisting of feeder currents, the neck, and the head. Also referred to as *Rip Tide* and *Tiderip*.

Rip Rap (also Riprap) — A facing layer (protective cover) of stones placed to prevent erosion or the sloughing off of a structure or embankment. A layer of man-made hard, durable material for bank protection and stabilization usually consisting of rock or stone. On steeper inclines, the stones may be secured with wire on some form of link fencing material. Also, a layer of large stones, broken rock, or precast blocks placed in random fashion on the upstream slope of an *Embankment Dam*, on a reservoir shore, or on the sides of a channel as a protection against waves, ice action, and flowing water. Very large rip rap is sometimes referred to as *Armoring*.

Rip Tide — See *Rip Current*.

Riparian — Pertaining to the banks of a river, stream, waterway, or other, typically, flowing body of water as well as to plant and animal communities along such bodies of water. This term is also commonly used for other bodies of water, e.g., ponds, lakes, etc., although *Littoral* is the more precise term for such stationary bodies of water. Also refers to the legal doctrine (*Riparian Doctrine* and *Riparian Water Rights*) that says a property owner along the banks of a surface water body has the primary right to withdraw water for reasonable use. Also see *Riverine*.

Riparian Area — The land immediately adjacent to lakes, rivers, and streams.

Riparian Areas (Habitat) — (1) Land areas directly influenced by a body of water. Usually such areas have visible vegetation or physical characteristics showing this water influence. Stream sides, lake borders, and marshes are typical riparian areas. Generally refers to such areas along flowing bodies of water. The term *Littoral* is generally used to denote such areas along non-flowing bodies of water. (2) Plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent *Lotic* and *Lentic* water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: (a) distinctively different vegetative species than adjacent areas, and (b) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between *Wetlands* and *Uplands*.

Riparian Areas [USFWS] — As defined by the *U.S. Fish and Wildlife Service (USFWS)*, “Riparian areas are plant communities continuous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic [related to or living in flowing water] and lentic [related to or living in standing water] water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: (1) distinctively different vegetative species than adjacent areas; and (2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland [areas].” Riparian areas support an array of habitats ranging from emergent, herbaceous species to broadleaf deciduous shrubs and trees to forested evergreens. Frequently, these vegetative components are associated with a variety of dynamic hydrological settings such as rivers, streams, lakes, ponds, oxbows, washes, arroyos, etc. Furthermore, of particular interest to the USFWS is that aquatic and fish productivity are directly related to a properly functioning and healthy riparian habitat. See *Riparian Classification (Mapping) System [USFWS]*.

Riparian Classification (Mapping) System [USFWS] — The Fish and Wildlife Act of 1956 authorized the *U.S. Fish and Wildlife Service (USFWS)* to map habitats used by fish and wildlife resources. Subsequently, Congress mandated that the USFWS, through the National Wetlands Inventory (NWI), was to identify, classify, and digitize all *Wetlands and Deepwater Habitats* in

the United States. As part of that project the USFWS recognized that *Riparian Areas*, typically adjacent to and dependent upon *Wetlands*, were the most important vegetative communities for wildlife species in the Western U.S. Although such areas are closely associated with wetland and *Upland* areas, the USFWS felt obligated to map these riparian areas independently due to their unique features. Specifically, riparian areas lack the amount or duration of water usually present in wetlands, yet are “wetter” than adjacent uplands and typically constitute a “transition zone” between wetlands and uplands. To better quantify and understand the dynamics of these crucial wildlife habitat areas, in late 1997 the USFWS adopted a classification system based primarily on extensive aerial mapping and detailed photographic analysis. The riparian classification system adopted by the USFWS applies primarily to areas of the western United States where mean annual evaporation exceeds mean annual precipitation. This classification and mapping system is for resource inventory purposes only and has no relationship to any wetland regulatory programs. The USFWS classification system is hierarchical, open ended, and uses a format of (1) systems, (2) subsystems, (3) classes, (4) subclasses, and (5) dominance types as described below:

- [1] **System** – A single unit category: Riparian vegetation (“Rp”);
- [2] **Subsystem** – Defines two categories reflecting the water source for the riparian area: *Lotic*, related to or living in flowing water (“1”), or *Lentic*, related to or living in standing water (“2”);
- [3] **Class** – Describes the dominant nonhydrophytic life form of riparian vegetation: (a) Forested (“FO”) woody vegetation usually greater than 6 meters (20 feet) in height; (b) Scrub/shrub (“SS”) woody vegetation usually less than 6 meters in height; and (c) Emergent (“EM”) erect, rooted vegetation with herbaceous stems;
- [4] **Subclass** – Further defines the Class category as either: Deciduous (“6”); evergreen (“7”); or mixed deciduous/evergreen (“8”);
- [5] **Dominance Type** – Refers to the dominant type vegetative species within the mapping unit, e.g., cottonwood (“CW”), aspen (“AS”), alder (“AL”), salt cedar (“SC”), Russian olive (“RO”), willow (“WT”), mesquite (“MQ”), mixed deciduous (“MD”), etc. Dominance types vary throughout the country and therefore the hierarchy is open-ended and may be supplemented by additional vegetative species as geographically necessary.

Based on the USFWS classification system, a riparian area code classification of “Rp1FO6CW” refers to riparian vegetation (“Rp”), lotic environment (“1”), forested (“FO”), deciduous (“6”), and the dominant type of vegetative species in the area being cottonwood (“CW”).

Riparian Doctrine — The system for allocating water used in England and the eastern United States, in which owners of lands along the banks of a stream or water body have the right to *Reasonable Use* of the waters and a *Correlative Right* protecting against unreasonable use by others that substantially diminishes the quantity or quality of water. The right is appurtenant to the land and does not depend on prior use. Under this doctrine, ownership of land along a stream or river (i.e., riparian lands) is an absolute prerequisite to a right to use water from that body of water and each such landowner has an equal right to withdraw “reasonable” amounts of water (whether or not he is presently using it or not) so long as downstream landowners are not unreasonably damaged. Contrast with *Prior Appropriation Doctrine*.

Riparian Ecosystem — A transitional ecosystem located between aquatic (usually *Riverine*) and terrestrial (upland) environments. Riparian ecosystems are identified by distinctive soil characteristics and vegetation communities that require free water.

Riparian Habitat — Areas adjacent to rivers and streams with a high density, diversity, and productivity of plant and animal species relative to nearby uplands.

Riparian Land — (1) Land situated along the bank of a stream or other, generally flowing bodies of water. (2) Land so situated with respect to a body of water that, because of such location, the possessor of the land is entitled to the benefits incident to the use of the water.

Riparian Lease — The written instrument setting forth the terms, conditions, and the date of expiration of the rights to use lands lying between the high water mark and the low water mark.

Riparian Owner — One who owns land on the bank of a river, or one who is the owner of land along, bordering upon, bounded by, fronting upon, abutting, or adjacent and contiguous to and in contact with a river or stream.

Riparian Proprietor — An owner of land, bounded generally upon a stream or river, and as such having a qualified property in the soil to the thread of the stream or river with the privileges annexed thereto by law.

Riparian Rights — (1) Water rights based on the ownership of land bordering a river or waterway. (2) A concept of water law under which authorization to use water in a stream is based on ownership of the land adjacent to the stream and is normally not lost if not used. (3) A doctrine of state water law under which a land owner is entitled to use the water on or bordering his property, including the right to prevent diversion or misuse of upstream waters. Riparian land is land that borders on surface water. (4) The rights of the owners of lands on the banks of watercourses, relating to the water, its use, ownership of soil under the stream, accretion, etc. The term is generally defined as the right which every person through whose land a natural watercourse runs has to the benefit of the stream as it passes through his land for all useful purposes to which it may be applied. Such rights include those such as hunting, fishing, boating, sailing, irrigating, and growing and harvesting wild rice, which rights extend over lakes and wetlands. See *Riparian Doctrine*. Also see *Riparian Water Rights*.

Riparian Vegetation — Plants adapted to moist growing conditions found along waterways and shorelines. They are frequently important to wildlife habitat because of their greater density and succulence.

Riparian Water — Water which is below the highest line of normal flow of the river or stream, as distinguished from flood water.

Riparian Water Rights — The rights of an owner whose land abuts water. They differ from state to state and often depend on whether the water is a river, lake, or ocean. In some cases, riparian rights also can attach to land which regularly receives flood waters from predictable sources such as annual snow melt. In such cases flash flooding and other unpredictable flood waters cannot be used to substantiate a riparian water right. The volume of water that a riparian has a right to use is seldom quantified.

Riparian rights are considered “part and parcel” of the land and are passed with title to the property. Also, the use of riparian water is limited to the watershed of the source from which the water is taken; therefore exports to other watersheds are typically not permitted. The doctrine of riparian rights is an old one, having its origins in English common law. Specifically, persons who own land adjacent to a stream have the right to make reasonable use of the stream’s natural flow on those lands within the watershed. (The emphasis on natural flow means that riparian rights cannot be claimed for long-term storage of water in a reservoir.) Riparian users of a stream share the streamflow among themselves, and the concept of priority of use (*Prior Appropriation Doctrine*) is not applicable. Under drought conditions, the users share shortages. Riparian rights cannot be sold or transferred for use on nonriparian land. Riparian rights to the waters of a lake, as opposed to a flowing stream, are often referred to as *Littoral Water Rights*. Also see *Appropriative Water Rights*, *Prescribed Water Rights*, *Reserved Water Rights*, *Correlative Water Rights* and *Reasonable Use Doctrine*.

Riparian Zone — (1) Areas adjacent to a stream that are saturated by groundwater or intermittently inundated by surface water at a frequency and duration sufficient to support the prevalence of vegetation typically adapted for life in saturated soil. (2) The transition area between the aquatic ecosystem and the nearby, upland terrestrial ecosystem. Zones are identified by soil characteristics and/or plant communities and include the wet areas in and near streams, ponds, lakes, springs and other surface waters. Also see *Riparian Areas*.

Ripe Snow — A term for wet, coarse, crystalline snow that will produce meltwater runoff with additional melting.

Ripple — (1) A small disturbance of the water’s surface, as by a breeze or by the distant movement of a craft within the water. Also see *Rip*. (2) To form or display little undulations or waves on the surface, as disturbed water does. (3) To flow with such undulations or waves on the surface. (4) A shallow expanse of running water in a stream, broken into small waves by a rocky or uneven bottom. (5) (Geology) A tiny ridge of sand on the bedding surface of a sediment, particularly a ripple mark. Also referred to as *Sedimentary Ripple*.

Ripple — (1) To form or display little undulations or waves on the surface, as disturbed water does. (2) To flow with such undulations or waves on the surface.

Ripple Mark — One of a series of small ridges produced especially on sand by the action of wind, a current of water, or waves.

Rise — See *Resurgence*.

Riser — A vertical pipe as for water.

Rising Limb — (1) The increasing portion of the storm *Hydrograph*. (2) A part of a *Hydrograph* that indicates an increase in stream flow as a result of rainfall or snowmelt. Contrast to *Falling Limb*.

Rising Sludge — (Wastewater Treatment) (1) Rising sludge occurs in the *Secondary Clarifiers* of *Activated Sludge* plants when the sludge settles to the bottom of the clarifier, is compacted, and then starts to rise to the surface, usually as a result of *Denitrification*. (2) The rising of previously settled solids in the settling tank of an activated sludge system. The immediate cause is denitrification, resulting in the formation of nitrogen gas and buoyancy of the sludge mass. The result is that solids are carried away with the effluent.

Risk Assessment — (1) A qualitative or quantitative evaluation of the environmental and/or health risk resulting from exposure to a chemical or physical agent (pollutant); combines exposure assessment results with toxicity assessment results to estimate risk. (2) (Dam Safety) As applied to dam safety, the process of identifying the likelihood and consequence of dam failure to provide the basis for informed decisions on a course of action.

Risk Characterization — Final component of *Risk Assessment* that involves integration of the data and analysis involved in hazard evaluation, dose-response evaluation, and human exposure evaluation to determine the likelihood that humans will experience any of the various forms of toxicity associated with a substance.

Risk Estimate — A description of the probability that organisms exposed to a specified dose of chemical will develop an adverse response (e.g., cancer).

Risk Factor — Characteristic (e.g., race, sex, age, obesity) or variable (e.g., smoking, occupational exposure level) associated with increased probability of a toxic effect

Risk Management — Decisions about whether an assessed risk is sufficiently high to present a public health concern and about the appropriate means for control of a risk judged to be significant.

Risk Management Program (RMP) — (Water Quality) A U.S. Environmental Protection Agency (EPA) program that requires certain entities throughout the United States who manufacture, store, distribute, handle or use any of 140 toxic, flammable and volatile substances to prepare a “worst-case scenario” crisis management/risk management plan. The objective of the risk management program is to develop a workable risk management plan.

Risk Specific Dose — The dose associated with a specified risk level.

River — (1) A natural stream of fresh water that is larger than a brook or creek, has a permanent or seasonal flow, and moves in a definite channel toward a sea, lake, or another river. (2) A natural stream of water of considerable volume, larger than a brook or creek. A river has its stages of development, youth, maturity, and old age. In its earliest stages a river system drains its basin imperfectly; as valleys are deepened, the drainage becomes more perfect, so that in maturity the total drainage area is large and the rate of erosion high. The final stage is reached when wide flats have developed and the bordering lands have been brought low. (3) (Geography) The channel or course permanently or seasonally occupied by such a stream.

River Assessments — Actions being undertaken by certain states, e.g., Arizona, California, Hawaii, Idaho, Kentucky, Maine, Montana, Oregon, and Washington, to create a base of information on river systems from which to make policy decisions. Such assessments would rely on existing data where available and gather new data as needed. For example, existing river assessments or inventories have ranked rivers according to their recreational, cultural, scenic, wildlife, and development potential. Certain development projects, for example hydroelectric power plants, were then approved on rivers only where they would be most appropriate to existing river uses and least harmful to other existing uses and potential benefits. Such assessments have been

instrumental in developing statewide development plans based on existing resource usage and protection measures..

River Banks — (1) The boundaries which confine the water to its channel throughout the entire width when the stream is carrying its maximum quantity of water. (2) The portion of the channel cross section that restricts lateral movement of water at normal discharges. Banks often have a gradient steeper than 45 degrees and exhibit a distinct break in slope from the stream bed.

River Bar — (Geology) A ridge or mound of *Alluvium* accumulated along the banks, in the channel, or at the mouth of a river.

River Basin — (1) A term used to designate the area drained by a river and its tributaries. (2) The area from which water drains to a single point; in a natural basin, the drainage area contributing flow to a given point on a stream.

River Basin Development — A program to develop the use of the water and land resources of a river basin, so coordinated as to obtain a greater efficiency of use than would be possible if the resources were developed by uncoordinated, multiple-purpose projects.

River Basin Plan — A plan for the development of water and related land resources to make the best use of such resources to meet the basin needs and make the greatest long-term contribution to the economic growth and social well-being of the people of the basin and the nation.

River Bottom — (Geology) The low-lying alluvial land through which a river flows.

River Breathing — A term for the rising and falling of the water level of a river.

River Channels — Natural or artificial open conduits which continuously or periodically contain moving water, or which forms a connection between two bodies of water.

River-Deposition Coast — (Geology) The coast of a delta bordered by lowlands and characterized by seaward bulges in the form of lobes that are crossed by river distributaries.

River Drift — (Geology) Rock material that is deposited by a river in one location after being transported from another location.

River End — The lowest point of a river that has no outlet to the sea, located where the water disappears as a result of *Evaporation* or *Percolation*.

River Facts — The following “river facts” were compiled by the conservation organization *American Rivers* as part of their education and awareness program.

- The United States has over 250,000 rivers equating to some 3.5 million river miles.
- The largest river is the Mississippi, which has a flow volume of 593,000 cubic feet per second at its mouth, or 429,310,000 acre-feet per year (filling *Lake Tahoe*, straddling the California and Nevada, border 3.5 times).
- The longest river is the Missouri, which flows for approximately 2,500 miles.
- More than 235,000 river miles in the United States have been channelized (nearly 7 percent of total river miles).
- More than 600,000 river miles are impounded behind dams (over 17 percent of total river miles).
- More than 25,000 river miles have been dredged for navigation.
- More than 50 percent of the nation's wetlands have been lost or destroyed nationwide in the past century.
- Nearly 40 percent of the rivers and streams in the U.S. are too polluted for fishing and swimming.
- Thirty percent of the native freshwater fish species in North America are threatened, endangered, or of special concern.

Longest rivers in the United States (Source: *Statistical Abstract of the U.S.*):

- Missouri – 2,540 miles
- Mississippi – 2,340 miles
- Yukon – 1,980 miles
- Rio Grande – 1,900 miles
- St. Lawrence – 1,900 miles
- Arkansas – 1,460 miles
- Colorado – 1,450 miles
- Atchafalaya – 1,420 miles
- Ohio – 1,310 miles
- Red – 1,290 miles
- Brazos – 1,280 miles
- Columbia – 1,240 miles
- Snake – 1,040 miles

River Flood Warning — A warning issued by the *National Weather Service (NWS)* when the height of water on a mainstem river is or is forecast to reach or exceed *Flood Stage*.

River Flooding — Inundation of a normally dry area along a river (usually the mainstem) due to increased water level or discharge. Because the drainage areas of mainstem rivers are large, they do not *Flash Flood* as their smaller tributary streams do. River flooding occurs more than a few hours after the causative event (usually widespread heavy precipitation and/or snowmelt) of the flood. In many cases, the end of flash flooding along tributary streams may be followed by or coincident with river flooding (i.e., heavy precipitation which initially causes flash flooding on tributaries goes on to cause river flooding on the larger rivers). Because of the longer time factor, river flooding usually can be forecast with much greater accuracy than flash flooding. The forecasting of river flooding is one of the primary duties of the *National Weather Service River Forecast Centers*.

River Flow Model — A simulation, generally mathematical, of a river's or drainage basin's *Hydrologic Cycle*, through a series of mathematical equations quantifying system inflows and outflows. Whenever possible, actual flow measurements for calibration purposes will be used.

River Forecast — A prediction of expected river stage or discharge, based on hydrologic and meteorologic factors.

River Form — The plan-view pattern and vertical cross-sectional shape of the river channel between river banks. Alluvial river form is described qualitatively as meandering, straight, or braided, and narrow and deep, or wide and shallow. Changes in river form cause changes in the flood plane. River form, although a small part of the total landscape, is of special interest to human endeavors because development traditionally has been along the fertile, level land of the flood plains of rivers. Changes in the river form consequently affect the quality of life and the value of property for these flood plain uses by man. Major river-form changes can cause significant differences in the surface runoff, in recharge to aquifers, and in sediment yields in affected basins, especially in arid and semi-arid regions. River-form changes along a river, therefore, can affect the frequency of flooding in two ways: (1) by changing the peak flow rate and (2) by changing the *Bankfull Capacity* of the river. This causes uncertainties in the delineation of flood-prone areas, i.e., the flood plain. Also referred to as *River-Channel Form*.

River Gage Reach — That stretch of a river on which the stage and/or flow at a particular gage is characteristic of stage and/or flow along that entire reach. Consequently, streamflow, depth, drainage area and slope are fairly uniform along this stretch and there are no major inflows, diversions, dams, etc.

River Left — Left side of the river when facing downstream.

River Mile — Distance of a point on a river measured in miles from the river's mouth along the low-water channel.

River Mileage — The linear distance along the meandering path of a stream channel determined in accordance with Bulletin No. 14 (October 1968) of the Water Resources Council.

River Morphology — The study of a river channel and the network of tributaries within the river basin, in which an aerial view and the shape of a given cross section within a limited reach are examined at several points along the channel. Also referred to as *Channel Morphology*, *Fluviomorphology*, or *Stream Morphology*.

River Profile — See *Stream Profile*.

River Rating — In terms of rafting and other navigable water sports, rivers are rated from I (easy) to VI (unrunnable), with class V rivers being the limit of prudent rafting. A plus sign (+) after a rating indicates there may be one or more rapids with levels of difficulty slightly above the level indicated, while a "P" after the rating indicates there is a portage available. Generally speaking, when in the company of professional guides with proper equipment, first-time and veteran rafters alike thrive on class III, III-IV and some IV rated river reaches. Also, a river's level of challenge can change greatly with fluctuations in water levels. The following are descriptions of river ratings:

- [1] **Class I** — Easy: Waves small; passages clear; no serious obstacles;
- [2] **Class II** — Medium: Rapids of moderate difficulty with passages clear;
- [3] **Class III** — Difficult: Waves numerous, high, irregular; rocks present along with eddies; rapids with passages clear though narrow, generally requiring expertise in maneuvering;
- [4] **Class IV** — Very Difficult: Long rapids; waves powerful and irregular; dangerous rocks; boiling eddies; powerful and precise maneuvering required;
- [5] **Class V** — Extremely Difficult: Exceedingly difficult; long and violent rapids, following each other almost without interruption; riverbed extremely obstructed; big drops; violent currents; very steep gradient;
- [6] **Class VI** — Unrunnable/unraftable: Should not even be attempted.

River Reach — Any defined length of a river.

River Right — Right side of the river when facing downstream.

River Run Gravel — (Geology) Natural gravel found in deposits that have been acted upon by running water.

River Stage — The elevation of the water surface at a specified station above some arbitrary zero datum (level).

River System — A natural system consisting of a river together with all its tributaries. Also referred to as a *Water System*.

River Tide — (Oceanography) A tide resembling an ocean tide and occurring in rivers that empty directly into the sea.

Riverbed (or River Bed) — A channel through which a river now flows or once flowed.

Riverine — (1) Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc. (2) Pertaining to or formed by a river; situated or living along the banks of a river, for example, a "riverine ore deposit." Also see *Riparian*.

Riverine (Systems) — Open-water habitats. Typically include all open water areas that occur within a defined channel of a stream as well as along perennial and intermittent stretches of streams and along some major dry washes. In some cases, riverine systems are bounded by *Palustrine Wetlands* that develop in the floodplain on either side of the defined channel. The riverine system and the adjacent palustrine wetlands are often referred to as *Riparian Habitat*. Also see *Wetlands* and *Wetlands, Paulustrine*. See *Wetland and Deepwater Habitat Classification System* and more detailed information on these systems.

Riverine Zone — The relatively narrow and well-mixed area of a reservoir immediately down-stream of the river inflow where current velocities decrease and significant sediment transport still occurs.

Rivers, Classifications — Classifications of waterways included in the *National Wild and Scenic Rivers System* are as follows:

- [1] **Recreational Rivers** — Rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shoreline, and that may have undergone some impoundment or diversion in the past.
- [2] **Scenic Rivers** — Rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive, and shorelines largely undeveloped but accessible in places by roads.
- [3] **Wild Rivers** — Rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted.

Riverwash — (Geology) (1) Any soil material that has been carried and deposited by a river. (2) An alluvial deposit in a riverbed or flood channel that is subject to erosion and deposition during recurring floods. (3) Barren alluvial land, usually coarse-textured, exposed along streams at low water, and subject to shifting during normal high water.

Rivulet — A small stream or brook; a streamlet.

RMP — See *Risk Management Program*.

Road — (1) See *Roadstead*. (2) (Geology) One of a series of erosional terraces formed in a glacial valley as the water level dropped in an ice-dammed lake.

Roadstead — A sheltered area of water near the shore with good holding ground for anchors.

Robinson Projection — (Geography) A compromise map projection showing the poles as lines rather than points and more accurately portraying high latitude lands and water to land ratio.

Roche Moutonnée — An elongated mound of bedrock worn smooth and rounded by glacial abrasion.

Rock-Basin Lake — See *Paternoster Lake*.

Rock Flour — Finely ground rock particles produced by glacial abrasion. Also referred to as *Glacier Meal*.

Rock Garden — A rapid thickly strewn with exposed or partially covered rocks that demand intricate maneuvering.

Rock Varnish — See *Desert Varnish*.

Rockbolt — A steel bar inserted into drill-holes in rock and secured for the purpose of ground control.

Rockfill Dam — An *Embankment Dam* in which more than 50 percent of the total volume comprises compacted or dumped pervious natural or crushed rock. Also see *Dam*.

Rodenticide — Any substance or chemical used to kill or control rodents.

Roil — (1) A small, turbulent, swiftly flowing section of a stream. (2) To make a liquid cloudy, muddy, or unsettled by stirring up the sediment.

Roily — (1) Turbulent or swirling as in roily water. (2) Muddy or sediment-filled. (3) Water that is turbid, muddy, agitated or disturbed.

Roll Cloud — A low, horizontal tube-shaped arcus cloud associated with a thunderstorms gust front. They are, however, completely detached from the thunderstorm base and are relatively rare.

Roller Wave — A *Reversal*. This term is used variously to mean curler and back roller.

ROM — Reverse Osmosis Membrane.

Rooster Tail — (1) Water or spray occurring at the intersection of two crossing waves, taking on a form that resembles a plume of feathers. (2) A high arching spray of water thrown up behind a fast-moving motorboat.

Root Hair — (Botany) A thin, hairlike outgrowth of an epidermal cell of a plant root that absorbs water and minerals from the surrounding soil.

Root Pressure — Pressure exerted in the roots of plants as the result of *Osmosis*, causing exudation from cut stems and *Guttation* of water from leaves.

Rootwad — A tree stump with roots that are strategically placed in a stream bank as part of rebuilding or restoring the bank. The stump may be dead wood or live and capable of sprouting and rooting.

Root Zone — The subsurface zone from the land surface to the depth interwoven by plant roots.

Rotameter — A device used to measure the flow rate of gases and liquids. The gas or liquid being measured flows vertically up a tapered, calibrated tube. Inside the tube is a small ball or bullet-shaped float (it may rotate) that rises or falls depending on the flow rate. The flow rate may be read on a scale behind or on the tube by looking at the middle of the ball or at the widest part or top of the float.

Rotating Biological Contractor (RBC) — (Water Quality) A means of wastewater treatment in which large, closely-spaced plastic discs are rotated about a horizontal shaft. The discs alternately move through the wastewater and the air, developing a biological growth on their surface.

Rotation — (Irrigation) Water delivery where a relatively constant supply flow is rotated to different users at varying times.

Rotation Delivery — A method of delivering water to the headgate from the project conveyance system on a rotational time basis. This delivery method is usually associated with high head (cfs) deliveries.

Rotation Management — A type of livestock grazing management system where pastures are grazed for only a portion of the year or season and rested for the remainder.

Rotifer — Any microscopic animal of the phylum *Rotifera*, found in fresh and salt waters and having one or more rights of cilia on the anterior end. Also called a *Wheel Animalcule*.

Rotten Ice — Soft, spongy ice in an advanced state of disintegration or melting, characterized by a honeycomb structure consisting of pockets filled with meltwater or seawater.

Rough Fish — Those species of fish considered to be of either poor fighting quality when taken on tackle or of poor eating quality, such as carp, gar, suckers, etc. Most species in this group are more tolerant of widely fluctuating environmental conditions than *Game Fish*.

Rough Ice — An expanse of ice having an uneven surface resulting from the formation of pressure ice, or the freezing in place of small fragments of floating glacier or sea ice.

Roughness — (1) A term used in hydraulics as a measurement or estimate of the resistance that streambed materials, vegetation, and other physical components contribute to the flow of water in the stream channel and floodplain. It is commonly measured as the Manning's roughness coefficient. (2) (Fluid Mechanics) A term for the height of the protrusions or irregularities on the non-smooth interior of a pipe wall.

Roughness Coefficient — (Hydraulics) A factor in velocity and discharge formulas representing the effect of channel roughness on energy losses in flowing water.

Roughness Coefficient, *n* (of a Channel) — A measure of the hydraulic impediment to flowing water either in a natural stream channel, ditch, or pipe. The roughness coefficient is highly variable and also depends on a number of factors which are, to a certain extent, interdependent. Some of the more important channel factors affecting the roughness coefficient include:

- [1] Surface Roughness
- [2] Vegetation
- [3] Channel Irregularity
- [4] Channel Alignment
- [5] Silting and Scouring
- [6] Obstructions
- [7] Size and Shape of Channel
- [8] Stage and Discharge
- [9] Seasonal Changes
- [10] Suspended Material and Bed Load

Recognizing several primary factors affecting the roughness coefficient, one mathematical approach to a determination of the value of n has been to calculate:

$$n = (n_0 + n_1 + n_2 + n_3 + n_4) m_5$$

where n_0 is the basic n value for a straight, uniform, smooth channel in the natural materials involved, n_1 is a value added to n_0 to correct for the effect of surface irregularities, n_2 is a value for variations in shape and size of the channel cross section, n_3 is a value for obstructions, n_4 is a value for vegetation and flow conditions, and m_5 is a correction factor for the meandering of the channel. The following table presents typical values of the roughness coefficient for specific channel conditions as noted in the formula above.

Channel Conditions		Values (n)	
Material Involved	Earth	n_0	0.020
	Rock out		0.025
	Fine gravel		0.024
	Coarse gravel		0.028
Degree of Irregularity	Smooth	n_1	0.000
	Minor		0.005
	Moderate		0.010
	Severe		0.020
Variations of Channel Cross Section	Gradual	n_2	0.000
	Alternating occasionally		0.005
	Alternative frequently		0.010-0.015
Relative Effect of Obstructions	Negligible	n_3	0.000
	Minor		0.010-0.015
	Appreciable		0.020-0.030
	Severe		0.040-0.060
Vegetation	Low	n_4	0.005-0.010
	Medium		0.010-0.025
	High		0.025-0.050
	Very high		0.050-0.100
Degree of Meandering	Minor	m_5	1.000
	Appreciable		1.150
	Severe		1.300

Roughness Factor — (Fluid Mechanics) A parameter used to determine flow resistance due to roughness of the surface over which the fluid flows.

Route of Exposure — The avenue by which a chemical comes into contact with an organism (e.g., inhalation, ingestion, dermal contact, injection).

Routing (Hydraulics) — (1) The derivation of an outflow *Hydrograph* of a stream from known values of upstream inflow, using the wave velocity and/or the storage equation. (2) A technique used to compute the effect of channel storage and translation on the shape and movement of a flood wave through a river reach.

ROWPU — Reverse Osmosis Water Purification Unit.

Rubble Ice — (Oceanography) Fragments of floating or grounded sea ice, resulting from the breakup of larger formations. Also referred to as *Rubble*.

Ruby Lake National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Ruby Lake NWR was established in 1938 and covers an area of 37,632 acres (58.8 square miles) consisting of marshes, open ponds and islands, bordered by wet meadows and grass/sagebrush-covered uplands. The Ruby Lake NWR, which collects the waters from over 160 springs along the base of the Ruby Mountains, lies within a closed drainage basin in Ruby

Valley of northeastern Nevada approximately 65 miles southeast of the town of Elko along the eastern flank of the rugged and scenic Ruby Mountains at an elevation of 6,000 feet above sea level. During the Pleistocene Epoch, the Ruby Mashers were part of a much larger body of water known as Franklin Lake, an Ice Age lake which covered some 470 square miles and was over 200 feet deep; however, today, only the Ruby and Franklin Lake marshes remain and provide an important refuge to nesting and migratory waterfowl and water birds using the migration corridors of both the Pacific and Central Flyways. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Ruderal — (1) (Ecology) Living or thriving on disturbed sites. (2) (Botany) Specifically, any plant that flourishes on a disturbed site, as on rubbish or in a wasteland area, often colonizing it. Some characteristics of ruderal species are: (a) a potentially high relative growth rate during the seedling phase; (b) early onset of flowering, self-pollination, rapid maturation and release of seeds; and (c) sustained seed production at the expense of ability for competition and tolerance to stress. Also referred to as *Aletophyte*.

Rugosity — A term used to indicate the degree of roughness of a test-well caused by drilling and subsequent wash-outs. In some wells, rugosity is caused by the intersection of fractures with the test well and may be an indication of secondary *Porosity* development and possible zones of increased *Transmissivity*.

Run — (1) To flow, especially in a steady stream. (2) A brook, small creek, or other small, swiftly flowing watercourse. (3) A pipe or channel through which something, i.e., water, flows. (4) A fall or slide, as of sand or mud. (5) The migration of fish, especially in order to spawn; a group or school of fish ascending a river in order to spawn, i.e., the seasonal upstream migration of *Anadromous* fish. (6) (Irrigation) The distance of gravity flow from the point of release to the end of the area to be watered. (7) (Nautical) To sail or steer before the wind or on an indicated course. (8) (Geology) A vein or seam, as of ore or rock.

Runlet — A *Runnel* (see below).

Runnel — (1) A rivulet; a brook. (2) A narrow channel or course, as for water. (Geology) (3) The channel eroded by such a rivulet or streamlet. (4) A trough-like hollow formed by the action of waves or tides on a tidal sand beach. Also see *Swale*.

Running Annual Average (RAA) — The twelve month average concentration of a chemical in samples collected more frequently than annually, where new sampling results replace the oldest results to maintain a constant twelve month average. For example, the RAA of an organic contaminant detected in January (10 ug/L), April (23 ug/L), July (15 ug/L), and Oct. (5 ug/L) would be 15 ug/L. When samples collected the following January contain only 4 ug/L of the contaminant, the 4 ug/L result would replace last January's 10 ug/L result and the RAA would be 12 ug/L.

Running Sand — See *Quicksand*.

Running Water — (1) Water that is moving in a stream or that is not stagnant or *Brackish*. (2) Water distributed through pipes and fixtures as a house with hot and cold running water.

Runoff (Run-Off) — (1) Water that runs off or flows over the land surface. That portion of precipitation that moves from the land to surface water bodies. Rain or melted hail, sleet, or snow that finds its way to a lake or stream by flowing over land. (2) That portion of precipitation which is not intercepted by vegetation, absorbed by the land surface or evaporated, and thus flows overland into a depression, stream lake or ocean (runoff called "immediate subsurface runoff" also takes place in the upper layers of the soil). (3) That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into the receiving waters. (4) That part of the precipitation, snow melt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers. It is the same as streamflow unaffected by artificial diversions, imports, storage, or other works of man in or on the stream channels. Runoff may be classified according to speed of appearance after rainfall or melting snow as direct runoff or base runoff, and according to source as surface runoff, storm interflow, or ground-water runoff. (5) The total discharge described in (1), above, during a specified period of time. (6) Also defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it.

Meteorological Factors Affecting Runoff:

- [1] Type of precipitation (rain, snow, sleet, etc.);
- [2] Rainfall intensity;
- [3] Rainfall amount;
- [4] Rainfall duration;
- [5] Distribution of rainfall over the drainage basin;
- [6] Direction of storm movement;
- [7] Antecedent precipitation and resulting soil moisture; and
- [8] Other meteorological and climatic conditions which affect evapotranspiration such as temperature, wind, relative humidity, and season.

Physical Basic Characteristics Affecting Runoff:

- [1] Land use;
- [2] Vegetation;
- [3] Soil type;
- [4] Drainage area;
- [5] Basin shape;
- [6] Elevation;
- [7] Slope;
- [8] Topography;
- [9] Direction of orientation;
- [10] Drainage network patterns; and

- [11] Ponds, lakes, reservoirs, sinks, etc. in the basin which prevent or alter runoff from continuing downstream.
- Runoff, Adjusted Mean Annual** — Average annual runoff adjusted for length of record by comparison with record at pivot stations.
- Runoff, Average Annual** — Average of water year runoff in inches or acre-feet for the total period of record.
- Runoff Coefficient** — The percentage of precipitation appearing as runoff, expressed as a constant between zero and one.
- Runoff Curve Number** — A rainfall-runoff parameter commonly used in the U.S. Department of Agriculture, *Natural Resources Conservation Service (NRCS)*, formerly the *Soil Conservation Service (SCS)*, hydrologic procedures. The larger the runoff curve number, the greater the percentage of rainfall that will appear as runoff. The runoff curve number is a function of soil type, land use, and land management practices.
- Runoff Cycle** — That portion of the *Hydrologic Cycle* between incident precipitation over land areas and its subsequent discharge through stream channels or *Evapotranspiration*.
- Runoff, Direct** — The runoff entering stream channels most immediately after rainfall or snowmelt. It consists of surface runoff plus interflow and forms the bulk of the *Hydrograph* of a flood. Direct runoff plus *Base Runoff* compose the entire flood hydrograph.
- Runoff, Groundwater** — That part of the runoff which has passed into the ground, has become groundwater, and has been discharged into a stream channel as spring or seepage water. Also referred to as *Base Runoff* or *Base Flow*.
- Runoff in Inches** — The depth, in inches, to which the drainage area would be covered if all the runoff for a given time period were uniformly distributed on it.
- Runoff Intensity** — The volume of water that is derived from a land surface per hour. Also referred to as *Runoff Rate*.
- Runoff Percentage** — Runoff expressed as a percentage of the precipitation.
- Runoff Plots** — Areas of land, usually small, arranged so the portion of rainfall or other precipitation flowing off and perhaps carrying soluble materials and soil may be measured.
- Runoff Rate** — The volume of water running off in a unit of time from a surface, expressed as inches of rainfall per hour, cubic feet per second, or other units. Also see *Runoff Intensity*.
- Runoff, Surface** — (1) That part of the runoff which travels over the soil surface to the nearest stream channel. (2) That part of the runoff of a drainage basin that has not passed beneath the surface since precipitation. Surface runoff is not the same as direct runoff.
- Run-of-River Dam** — A hydroelectric generating power plant that operates based only on available streamflow and some short-term storage (hourly, daily, or weekly). Compare to *Storage Reservoir*.
- Runout** — The area where an avalanche slows down or stops, depositing its debris. Also see *Water Yield*.
- Runs** — An area of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.
- Runway** — (Geology) A stream channel.
- Rural-Domestic Water** — The rural domestic category includes water uses for domestic needs, stock watering, yard irrigation, etc., of individual homes, farms or ranches, and rural centers with a population of typically less than about 250 people.
- Rural Water Use** — Water used in suburban or farm areas for domestic and livestock needs. The water generally is self supplied (i.e., not supplied by a *Public Water Supply System*) and includes domestic use, drinking water for livestock, and other uses, such as dairy sanitation, evaporation from stock-watering ponds, and cleaning and waste disposal. Uses may also include suburban developments such as apartment houses, or trailer courts with their own wells, and tracts of homes served by a central cooperatively owned well, or small water company for which no other source is available. Also see *Self-Supplied Water*.

S

Sacramento Model — A dynamic *River Flow Model* or *Water Budget Model*, run on a computer at various intervals, which accounts for all water entering, stored in, and leaving a *Drainage Basin*. Though many parameters are used in this water balance accounting process, precipitation has the main impact on runoff.

Sacramento–San Joaquin Delta [California] — See *Bay–Delta [California]*, *Central Valley [California]*, *Central Valley Project (CVP) [California]*, and *State Water Project (SWP) [California]*.

Sacrificial Anode — (1) An easily corroded material deliberately installed in a pipe or intake to give it up to corrosion while the rest of the water supply facility remains relatively corrosion-free. (2) An easily corroded material deliberately installed in a pipe or tank. The intent of such an installation is to give up (sacrifice) this anode to corrosion while the water supply facilities remain relatively corrosion free.

Safe — Condition of exposure under which there is a “practical certainty” that no harm will result in exposed individuals, as in contaminant-free *Safe Water*.

Safe Drinking Water Act [SDWA] (Public Law 93–523) — An amendment to the *Public Health Service Act* which established primary and secondary quality standards for drinking water. The SDWA was passed in 1976 to protect public health by establishing uniform drinking water standards for the nation. In 1986 SDWA Amendments were passed that mandated the *U.S. Environmental Protection Agency (EPA)* to establish standards for 83 drinking water contaminants by 1992 and identify an additional 25 contaminants for regulation every 3 years thereafter. See *Drinking Water Standards*, *Drinking Water Standards [Nevada]*, *Primary Drinking Water Standards*, *Secondary Drinking Water Standards*, *Water Contaminants*, *Water Treatment Disinfectants*, *Water Treatment Processes*, *Water Treatment Technologies*, *Water Quality Threats*, and *Waterborne Diseases*.

Safe Water — (1) Water that does not contain harmful bacteria, or toxic materials or chemicals. Water may have taste and odor problems, color and certain mineral problems and still be considered safe for drinking. (2) Water that does not contain harmful bacteria, toxic materials, or chemicals, and is considered safe for drinking even if it may have taste, odor, color, and certain mineral problems.

Safe Yield — (1) The rate at which water can be withdrawn from supply, source, or an aquifer over a period of years without causing eventual depletion or contamination of the supply. (2) A rate of extraction that does not deplete the basin over time. (3) The annual quantity of water that can be taken from a source or supply over a period of years without depleting the source beyond its ability to be replenished naturally in “wet years”. (4) (Groundwater) The amount of water that can be withdrawn from an aquifer without producing an undesired effect. (5) (Surface Water) The amount of water that can be withdrawn or released from a reservoir on an ongoing basis with an acceptably small risk of supply interruption (i.e., reducing the reservoir storage to zero.) More commonly referred to a *Perennial Yield* and *Sustained Yield*. Generally consists of the rate of *Natural Recharge*, *Artificial (or Induced) Recharge*, and *Incidental Recharge*.

Sag Pipe — A section of a sewer line that is placed deeper in the ground than normal in order to pass under utility piping, waterways, rail lines, highways, or other obstacles. The sewer line is raised again after passing under the obstacle. Also referred to as *Inverted Siphon*.

Sag Pond — (1) A small body of water occupying an enclosed depression or sag formed where active or recent fault movement has impounded drainage. (2) (California) One of many ponds and small lakes along the San Andreas Fault.

Salina — (1) Any body of water, such as a salt pond, having a high concentration of dissolved salts. (2) A salt marsh, spring, pond, or lake. (3) (Geology) A region, such as a salt pan or salt-encrusted playa, where deposits of crystalline salt are formed or found. (4) An area of land encrusted with salt. (5) An inland marsh subject to intermittent overflow by salt water.

Salination — (1) The process whereby soluble salts accumulate in the soil. (2) A detrimental by-product of irrigation which carries natural-occurring salts. Inadequate rainfall and practically exclusive use of irrigation waters, combined with especially high rates of evaporation and transpiration, causes minerals and salts to accumulate in the soil near the plant’s roots. This buildup of salts in the soil has typified irrigation systems and contributed directly to the loss of soil productivity and possible field abandonment. One method to mitigate some of these effects, *Leaching*, which necessitates using amounts of water beyond that required to meet the crop’s needs, only works where soils are well drained. Relatively impermeable layers of clay complicate the drainage problem by inhibiting the downward movement, or *Percolation*, of drainage water.

Saline — (1) Term used to describe waters containing common salt, or sodium chloride. (2) Of or containing any of the salts of the alkali metals or magnesium. (3) Salty. Possessing a high degree of dissolved mineral matter, i.e., common salts, in water. (4) As applied to water, containing dissolved salts in concentrations which make the water undesirable or unfit for most withdrawal uses. Saline water usually has a total dissolved solids content of 1,000 ppm or more.

Saline-Alkali Soil — (Geology) A soil unusable for agricultural purposes because it contains more than 15 percent exchangeable sodium, has a high content of soluble salts, and a pH less than 9.5. Also referred to as *Salina-Alkali Soil*.

Saline/Poor Quality Aquifer — An aquifer containing water that is high in total dissolved solids, and is unacceptable for use as drinking water.

Saline Marsh — A saturated, poorly drained area, intermittently or permanently water covered, having aquatic and grasslike

vegetation whose water chemistry contains various dissolved salts.

Saline Seeps — Wet areas in non-irrigated soils where soluble salts accumulate from the evaporation of the seeping water and crop or grass production is reduced or eliminated.

Saline Sodic Land — Soil that contains soluble salts in amounts that impair plant growth but not an excess of exchangeable sodium.

Saline Soil — A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most plants.

Saline Water — Water containing dissolved solids; generally referring to solid contents in excess of 1,000 parts per million (ppm) *Total Dissolved Solids (TDS)*. The *U.S. Geological Survey (USGS)* classifies the degree of salinity of these more mineralized bodies of water as shown in the following table:

Salinity Measure	Total Dissolved Solids (ppm)
Slightly Saline	1,000-3,000 ppm
Moderately Saline	3,000-10,000 ppm
Very Saline	10,000-35,000 ppm
Brine	More than 35,000 ppm

Salinity — (1) The concentration of dissolved salts in water or soil water. Salinity may be expressed in terms of a concentration or as an electrical conductivity. When describing salinity influenced by seawater, salinity often refers to the concentration of chlorides in the water. (2) The relative concentration of dissolved salts, usually sodium chloride, in a given water. (3) A measure of the concentration of dissolved mineral substances in water. (4) The relative concentration of salts, usually sodium chloride, in a given water sample. It is usually expressed in terms of the number of parts per thousand (‰) or parts per million (ppm) of chloride (Cl). Although the measurement takes into account all of the dissolved salts, sodium chloride (NaCl) normally constitutes the primary salt being measured. Salinity can harm many plants, causing leaves to scorch and turn yellow and stunting plant growth. As a reference, the salinity of seawater is approximately 35‰ or 35,000 ppm. See *Salts* for comparative salt concentrations in water. Also see *Total Dissolved Solids*.

Salinity Control — The physical control, management, and use of water and related land resources in such a way as to maintain or reduce salt loading and concentrations of salt in water supplies.

Salinity Current — (Oceanography) A density current in the ocean whose flow is caused by its relatively higher salinity, and therefore its greater density, in comparison to the surrounding water.

Salinity Intrusion — The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater bodies.

Salinization — The accumulation of salts in soil to the extent that plant growth is inhibited. This is a common problem when crops are irrigated in arid regions; much of the water evaporates and salts accumulated in the soil. Also see *Leaching Requirement*.

Salmonella Typhosa — A waterborne microorganism which is the causative agent of typhoid fever.

Salmonellosis — The bacterial disease caused by the presence of bacteria of the genus *Salmonella*. The disease is a type of food poisoning characterized by a sudden onset of gastroenteritis involving abdominal pain, diarrhea, fever, nausea, and vomiting. A variety of foods, such as sweets, meats, sausages, and eggs, can be the mode of infection. Pet turtles and birds can also transmit the bacteria.

Salt — (1) Most generally, all the minerals dissolved in water. (2) A chemical class of ionic compounds formed by the combination of an acid and a base. Most salts are the result of a reaction between a metal and one or more nonmetals. See *Salts*, below.

Saltation — Particle movement in water or wind where particles skip or bounce along the stream bed or soil surface.

Salt Balance — (1) A condition in which specific or total dissolved solids removed from a specified field, stratigraphic zone, political area, or drainage basin equals the comparable dissolved solids added to that location from all outside sources during a specified period of time. (2) The salt balance of an irrigated area is commonly defined as the difference between the total dissolved solids brought to the land annually by the irrigation water and the total solids carried away by the drainage water. When the input of salts is less than the output, the salt balance is said to be favorable; when the input is greater than the output, the salt balance is unfavorable. In this way, the salt balance is an important indicator of salt accumulation in the root zones and the suitability of soils for agriculture.

Salt Flat — A salt-encrusted flat area resulting from evaporation of a former body of water.

Salt Lake — (1) A landlocked body of water that has become salty through evaporation. (2) An inland body of water with no outlet to the sea, containing a high concentration of dissolved salts. Also referred to as a *Brine Lake*.

Salt Marsh (or Saltmarsh) — (1) Saltwater wetlands that occur along many coasts north and south of the tropics. *Spartina* grasses are the dominant vegetation in many salt marshes. (2) Low areas adjacent to the sea that are covered with salt-tolerant vegetation (*Halophytes*) and regularly flooded by the high tide. As part of the *Wetland* systems, such areas help to stabilize shorelines and prevent erosion from tide and wave actions. Also, similar inland areas near saline springs or lakes, though not regularly flooded. (Ecology) (3) A habitat, characterized by high salinity, found at the edge of aquatic ecosystems, most commonly in tropical or subtropical regions. (4) A type of salt-tolerant vegetation that grows on the mud banks formed at a river's mouth.

Salt Pan — (1) An undrained natural depression in which water gathers and leaves a deposit of salt on evaporation. (2) A small, shallow, undrained, natural depression containing a salt deposit produced by the accumulation and subsequent evaporation of water; or a shallow lake of somewhat salty water occupying such a depression. (3) A large pan used to collect salt by evaporation of a salt solution such as seawater.

Salt Sink — A body of water too salty for most freshwater uses.

Salt-Spray Climax — (Ecology) A climax community occurring along exposed Atlantic and Gulf seacoasts that is inhabited by plants able to withstand the effects of salt transported from the sea by winds.

Salt Water — Water which contains a relatively high percentage of sodium chloride.

Salt-Water Barrier — A physical facility or method of operation designed to prevent the intrusion of salt water into a body of fresh water. Also see *Hydraulic Barrier*.

Salt-Water Front — (Oceanography) The interface between salt water and fresh water in an *Aquifer* or *Estuary*.

Salt-Water Intrusion — The invasion of a body of fresh water by a body of salt water, due to its greater density. It can occur either in surface or ground-water bodies. The term is applied to the flooding of freshwater marshes by seawater, the migration of seawater up rivers and navigation channels, and the movement of seawater into freshwater aquifers along coastal regions.

Salt-Water Marsh — Low, flat marshlands subject to inundation by salt waters; may be tidal or non-tidal; normally the only vegetation present is salt-tolerant bushes and grasses. Also see *Marsh* and *Tidal Marsh*.

Salt-Water Underrun — (Oceanography) A density current of seawater moving under fresh water in an *Estuary*.

Salt-Water Wedge — (Oceanography) An intrusion of seawater into a tidal estuary, characterized by a marked increase in salinity from top to bottom, so that the bottom layers penetrate farther upstream than the upper layers.

Saltmarsh Plain — (Ecology) A *Salt Marsh* that has been raised above the water level and has become dry land.

Salton Sea [California] — An inland sea located in the southeastern corner of California in the Sonoran Desert of Imperial and Riverside counties just north of El Centro, California. The present Salton Sea was created and named in 1905 when the Colorado River flooded and broke through irrigation structures, filling the Salton Basin. At 228 feet below sea level, the Salton Sea is one of the lowest places in the United States. The bed of the Salton Sea is only five feet higher than the lowest spot in Death Valley, California. At its present surface elevation, the Salton Sea is approximately 35 miles long by 15 miles wide, while its average depth is nearly 30 feet and its deepest point is approximately 51 feet. The Salton Sea contains 7.3 million acre-feet of water and evaporates 1.3 million acre-feet, or nearly 18 percent of its total volume each year. The Salton Sea has a surface area of 376 square miles, making it nearly twice as large as *Lake Tahoe* (but considerably smaller in volume than Lake Tahoe's 122 million acre-feet). Based on its surface area, the Salton Sea is the largest lake in the State of California. The Salton Sea is actually a lake which occupies a desert basin known as the Salton Sink (also referred to as the Salton Basin or the Salton Trough). Due to its location in the Colorado Desert ecosystem, an area with average annual precipitation of less than 3 inches per year, the Salton Sea receives minimal inflow (recharge) from this source. Sources of inflow to the Salton Sea include: (1) Alamo River (46% of total inflows); (2) New River (32% of inflows); (3) agricultural drains (8% of inflows); (4) Whitewater River (7% of inflows); (5) groundwater (4% of inflows); (6) surface precipitation (3% of inflows); (7) San Felipe Creek (0.6% of inflows); and (8) Salt Creek (0.4% of inflows). (Salinity) As an agricultural drainage reservoir, the Salton Sea serves an important purpose for the highly productive agricultural valleys that adjoin it. As an agricultural sump, the Salton Sea consists primarily of commercial agricultural drainage. In fact, 90 percent of the entire inflow to the Salton Sea is agricultural runoff from the Imperial, Coachella, and Mexicali valleys. The rich agriculture harvest of these valleys would not be possible without the drainage repository afforded by the Salton Sea. This inflow carries nutrients, such as phosphates and nitrates, which support the rich and abundant life in the Salton Sea. Inflows also carry an abundance of salt (thereby giving the sea its name). Currently, the salinity level of the Salton Sea is between 41,000 and 43,000 parts per million (ppm) of *Total Dissolved Solids (TDS)*, compared to 280,000 ppm for Utah's *Great Salt Lake*, about 210,000 ppm for the Dead Sea, 87,000 ppm for California's *Mono Lake*, and 35,000 for the Pacific Ocean. (Wildlife Habitat) The wildlife habitat formed by the Salton Sea and Basin contains 35,484 acres of salt marsh and open water, and 2,000 acres of pasture and freshwater marsh. Presently, the fishery in the Salton Sea is thriving. However, if the concentrated salt level of the Salton Sea increases beyond 44,000 ppm, it is expected that all the fish, except the Tilapia, will cease to reproduce. Tilapia can survive up to 60,000 ppm. The Salton Sea has one of the most diverse bird species of any U.S. *Fish and Wildlife Service (USFWS) National Wildlife Refuge (NWR)* in the western United States. Four million birds are estimated to use the Salton Sea each day in winter, more than any other waterfowl resource in the nation. More than 400 species of birds have been observed at the Salton Sea and Imperial Valley regions – almost half of the 900 species known to exist on the North American continent. (Restoration) The Salton Sea Restoration Project currently underway is intended to address a number of critical challenges affecting the sustainability of this water body and its critically-important wildlife habitat area:

- [1] **Salinity** – Salinity has been identified as the Salton Sea's most crucial challenge. Most of the water entering the Salton Sea comes indirectly through agricultural drainage from the Colorado River and is salty when it arrives. The water brings the equivalent of a trainload of salt every day. Because the Salton Sea has no outlet, high evaporation rates further concentrate the salts and threaten the lake's fish population, as well as the birds which depend on the fish for food. To maintain the Salton Sea at current levels of salinity, several million tons of salt must be removed annually.
- [2] **Nutrients** – As an agricultural drainage sump, the nature of the Salton Sea is to be *Eutrophic*, or rich in nutrients. While the nutrients support a rich and abundant life in the Salton Sea, their continued inflow from both urban and agricultural runoff, and the continued increased concentration of these nutrients through high rates of evaporation, pushes the sea's *Nutrient Loading* to dangerous levels for all the basin's wildlife.
- [3] **Elevation** – Because the Salton Sea is a closed basin (i.e., no outflows except through evaporation), increases or reductions in inflows can dramatically change the elevation of the lake's shoreline, either flooding or stranding seaside structures and establishments during wet years and drought years. Because of this inability to control the sea's surface elevation, reservation land, seaside homes and marinas, boat facilities, parks, and agricultural fields have experienced periodic and costly flooding.
- [4] **Bird Disease** – Bird die-offs from avian diseases occur at generally the same rate as bird die-offs elsewhere. However, because of their large numbers and concentrations in this one area, the likelihood of one sick bird infecting

others is dramatically increased in this region. Bird diseases such as avian botulism, Newcastle's disease, or avian cholera have periodically caused extensive die-offs of waterfowl. Limiting such outbreaks is critically important due to the very large proportions of some bird populations hosted by this area and the fact that an epidemic could decimate many endangered, threatened, or sensitive species of birds that use the Salton Sea and Basin.

(History) The Salton Trough (Basin) is a below sea-level topographic depression extending from Palm Springs, California, on the north to the divide with the Gulf of California on the south. The basin has an extended history of filling up and forming inland lakes, which eventually dry up. Geographically, it appears that at one time the Salton Basin or Trough was a northern extension of the Gulf of California. Geologic evidence has tended to show that heavy silting and deposition by the highly turbid Colorado River effectively created a hydrographic "divide" between these depressions, with the Salton Basin drainage extending to the north and the Gulf of California drainage extending to the south. Thereafter and throughout history and extending back at least 10,000 years before present, extensive deposition caused the Colorado River to periodically alter its course to the north and then to the south, creating the intermittent lakes which have formed in the Salton Basin. Based on the paleoshorelines left on the surrounding mountains, scientists found that the first large lake to form in more recent history was Lake Cahuilla, which formed between 500 and 700 A.D. This lake was created when the Colorado River silted up its normal southern egress to the Gulf of California and swung northward through two overflow channels into the Salton Basin. Lake Cahuilla covered approximately 3,900 square miles, or an area about the size of the State of Delaware (or about 10 times the Salton Sea's present size) and had a surface elevation slightly above sea level (making it over 280 feet deep). Evidence of an ancient shoreline suggests that Lake Cahuilla occupied the basin until about 300 years ago. Fossil remains show that Lake Cahuilla was probably a freshwater lake and at its zenith supported an enormously rich ecosystem. Over time it also evaporated and attained high salinity levels much like what is happening with the Salton Sea today. More recently, between 1824 and 1904, the Colorado River flooded into the Salton Basin no fewer than eight times. For example, an 1840 flood created a salt lake three quarters of a mile long and a half a mile wide, and then in June 1891 another outpouring of the Colorado River created a lake 30 miles long and 10 miles wide in the Salton Basin. After each northern diversion, the Colorado River again filled its newly-formed bed and returned to a southern flow into the Gulf of California. It is not certain how many times the Colorado River's waters have filled the Salton Basin over the centuries, but human intervention has been responsible for inundating the basin only once. The present Salton Sea was formed between 1905 and 1907 when the Colorado River flooded and burst through poorly constructed irrigation control system south of Yuma, Arizona. Practically the entire flow of the Colorado River filled the Salton Basin for a period of 18 months, inundating communities, farms, and the main line of the Southern Pacific Railroad. Continued filling of the Salton Sink was finally stopped in 1907, when a line of protective levees was built by boxcars dumping boulders into the breach from Southern Pacific tracks. By then, this inland lake had grown to about 40 miles long and 13 miles wide, and covered an area of approximately 400 square miles.

Salts — (1) Combinations of common earth elements and compounds: calcium, magnesium, potassium, sodium, chloride, bromide, sulfate, carbonates and bicarbonate, nitrate, and others. Sufficiently diluted, salts are usually harmless for most water uses and are even necessary for plant growth. Excessive amounts of dissolved mineral salts, however, are detrimental to practically all water uses, including agriculture and domestic uses. (2) Salts are the minerals that water picks up as it passes through the air, over and under the ground, and through household and industrial uses. A compound composed of the positive ion from a base and the negative ion from an acid; i.e., a metal ion and a nonmetal ion, such as KBr (Potassium Bromide). The proportions or concentrations of salts in water is a determining factor in evaluating its quality. The concentration of salts in fresh water is, on the average, so small that it is expressed in parts per million (ppm), which is equivalent to milligrams per liter (mg/L). The table below presents examples of average concentrations of dissolved salts in different types of water:

Sources of Water	Salt Concentrations (ppm)
Distilled	0
Rain	10
Lake Tahoe (California/Nevada)	70
Truckee River (California)	100
Suwannee River	150
Lake Michigan	170
Missouri River	360
Pecos River	2,600
Pyramid Lake (Nevada – 1997)	5,000
Walker Lake (Nevada – 1997)	12,500
Walker Lake (Nevada – 2001)	14,000
Ocean	35,000
Mono Lake (California)	78,000
Great Salt Lake (Utah) – South Arm	85,000
Great Salt Lake – North Arm	175,000
Brine Well	125,000

Sources of Water	Salt Concentrations (ppm)
Dead Sea	250,000

Saltierra — (Geology) A salt deposit that is left behind after a shallow inland lake evaporates.

Salvage — (1) Saving or conserving water by improving the efficiency of use (e.g., by lining irrigation canals so seepage losses are reduced). (2) Water available for beneficial use because an existing permittee or water right holder does not use their full appropriation due to the implementation of water conservation measures.

Salvage Harvest — Removal of dead and dying trees resulting from insect and disease epidemics or wildfire.

Salvaged Water — The part of a particular stream or other water supply that is saved from loss, in respect to quantity or quality, and is retained and made available for use.

Sample — (Statistics) The sample consists of a number of randomly-selected, representative observations about an economic phenomenon; a part of a population taken to estimate a parameter of the whole population. The underlying assumptions are that we do not have the means to measure the entire population of events and that the sample, if properly selected, will accurately represent the behavior and characteristics of the entire population (of events) within specified limits of probability. Types of samples include:

- [1] **Random** — A sample drawn without bias from a population in which every item has an equal chance of being drawn;
- [2] **Representative** — A sample drawn in such a way that it gives a true value for the population from which it was drawn.

Contrast with *Population* and *Census*.

Sample Size — (Statistics) The number of individual observations. The sample size, i.e., number of observations about a particular event or phenomenon, has important implications on how representative the sample is of the *Population*.

(National Marine) Sanctuary Advisory Councils — See *National Marine Sanctuaries*.

Sand — (1) Composed predominantly of coarse-grained mineral sediments with diameters larger than 0.074 mm (0.0029 inch) and smaller than 2 mm (0.079 inch) in diameter. (2) Commonly refers to siliceous detrital material composed mainly of quartz particles of sand size.

Sand Boil — A spring that bubbles through a river levee, ejecting sand and water as the river water is forced through permeable layers of sands and silts below the levee during flood stage. Also referred to as *Blowout*.

Sand Dune — Naturally occurring accumulations of sand in ridges or mounds landward of the beach.

Sand Filter — (Water Quality) (1) A device used to remove particles from drinking water prior to distribution to customers. The water is allowed to *Percolate* through a chamber containing sand of various grain sizes, with the finest grain size located on the top. The particles in the water are removed at the surface of the sand and later discarded by reverse flushing. (2) (Wastewater Treatment) Devices that remove some suspended solids from sewage. Air and bacteria decompose additional wastes filtering through the sand so that cleaner water drains from the bed.

Sand Trap — (Irrigation) A device, often a simple enlargement in a ditch or conduit, for arresting the heavier particles of sand and silt carried by the water.

Sandpaper — In a river system, the small choppy waves over shallows.

Sandstone — A sedimentary rock composed of abundant rounded or angular fragments of sand set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material.

Sandstone Aquifer — The type of aquifer supplying groundwater to large parts of the United States upper Middle West, Appalachia, and Texas. The water-bearing formation is often contained by shale strata, and the water has high levels of iron and magnesium.

Sandbar — A ridge of sand built up by currents, especially in a river or in coastal waters.

Sanitary Defects — Conditions that may permit the contamination of a water supply during or after treatment. These include connections to unsafe water supplies, raw water bypasses in treatment plants, plumbing fixtures improperly designed and installed, and leaking water and sewer pipes in the same trench.

Sanitary Landfill — (1) A disposal site employing methods of disposing of solid wastes in a manner that minimizes environmental hazards by spreading, compacting to the smallest practical volume and applying cover material over all exposed wastes at the end of each operating day. (2) A disposal area for solid wastes where the wastes are compacted and covered by a layer of impermeable material, such as clay, daily.

Sanitary Seal (Water Well) — The neat cement seal at the top of a water well intended to prevent well contamination from surface water or shallow groundwater flows containing potential contaminants.

Sanitary Sewer — (1) A pipe or network of pipes which transport only municipal, commercial, or industrial wastewater (sewage) and not rain or storm waters from streets. (2) A sewer that transports only wastewaters (from domestic residences and/or industries) to a wastewater treatment plant.

Sanitary Survey — An on-site review of the water sources, facilities, equipment, operation and maintenance of a public water system to evaluate the adequacy of those elements for producing and distributing safe drinking water.

Sanitary Water — Water discharged from sinks, showers, kitchens, or other nonindustrial operations, but not from commodes. Also referred to as *Gray Water*.

Sandy Soil — Soils that have comparatively large particles that are rounded rather than flattened. Compared to clay soils, sandy soils contain much more soil and air, drain well, and warm quickly. They also dry out quickly, which necessitates more frequent watering that washes out valuable nutrients. Also referred to as "light" soil.

Sanitary Fill — Used to describe the dumping process whereby the garbage or other refuse is covered with soil, thus controlling

smell, rodent activity, etc., and speeding the decay of organic substances.

Saprobien System — (Water Quality) A European system of classifying organisms according to their response to organic pollution in slow-moving streams. Classifications include:

- [1] **Alpha-Mesaprobic Zone** – Area of active decomposition, partly *Aerobic*, partly *Anaerobic*, in a stream heavily polluted with organic wastes;
- [2] **Beta-Mesaprobic Zone** – That reach of a stream that is moderately polluted with organic wastes;
- [3] **Oligosaprobic Zone** – That reach of a stream that is slightly polluted with organic wastes and contains the mineralized products of self-purification from organic pollution, but with none of the organic pollution remaining;
- [4] **Polysaprobic Zone** – That area of a grossly polluted stream that contains the complex organic wastes that are decomposing primarily by anaerobic processes.

Sapropel — (1) A mud rich in organic matter formed at the bottom of a body of water. (2) A fluid slime found in swamps and bogs as a product of *Putrefaction*.

Saprophyte — An organism, especially a fungus or bacterium, that grows on and derives its nourishment from dead or decaying organic matter that help natural decomposition of organic matter in water.

Sapwood — Newly formed outer wood that lies just inside the cambium of a tree trunk and is usually lighter in color and more active in water conduction than the heartwood.

SARA — Superfund Amendments and Reauthorization Act.

Sargasso Sea — (Oceanography) An extensive area in the North Atlantic Ocean, northeast of the West Indies, characterized by unusually calm waters and by the presence of extensive areas of free-floating marine plants. (The name was derived from the Portuguese name for a type of seaweed.)

Sastruga — (Russian) A long wavelike ridge of snow, formed by the wind and found on the polar plains.

Satellite (Wastewater Treatment) Plant — Generally refers to a wastewater treatment facility in an outlying area, not connected to the main plant.

Satin Ice — See *Acicular Ice*.

Saturated — (1) Generally, filled to capacity; having absorbed all that can be taken up; soaked through with moisture. (2) (Hydrologic) A condition often used in reference to soils in which all voids or pore spaces between soil particles are filled with water. (3) (Chemistry) Describes a solution in its most concentrated state in which dissolved material can remain in solution under given conditions of temperature, pressure, etc.; a solution that contains the maximum possible amount of a substance under the given conditions.

Saturated Adiabatic Lapse Rate — The lapse rate in the saturated lower layers of the air. It is equal to about 3.4EF per 1,000 feet in elevation.

Saturated Air — Moist air in a state of equilibrium with a plane surface of pure water or ice at the same temperature and pressure; i.e., air whose vapor pressure is the saturation vapor pressure and its relative humidity is 100 percent.

Saturated Material — A material whose openings or pores are filled with water.

Saturated Flow — The liquid flow of water in soils that occurs when the soil pores in the wettest part of the soil are completely filled with water and the direction of flow is from the wettest zone of higher potential to one of lower potential.

Saturated Soils — Soils that have absorbed, to the maximum extent possible, water from rainfall or snowmelt. Any further precipitation on saturated soils will result in surface runoff with down-gradient affects on flooding and erosion.

Saturated Solution — (Chemistry) A solution that contains a sufficient amount of a substance so that no more will dissolve under the given conditions; i.e., the concentration of dissolved solute is or would be in equilibrium with any excess undissolved solute; the undissolved solute need not actually be present for the description to apply.

Saturated Thickness (Aquifer) — The thickness of the portion of the aquifer in which all pores, or voids, are filled with water. In a *Confined Aquifer*, this is generally the aquifer thickness. In an *Unconfined Aquifer*, this is the distance between the water table and the base of the aquifer.

Saturated Vapor Pressure — The pressure exerted by the vapor in a saturated space.

Saturated Zone — (1) The area below the water table where all open spaces are filled with water. (2) The part of a water bearing layer of rock or soil in which all spaces, large or small, are filled with water. (3) The zone in the earth's crust, extending from the water table downward, in which all open pore spaces in the soil or rock are filled with water at greater than atmospheric pressure. A term used synonymously with the *Zone of Saturation*. Also referred to as *Phreatic Zone*.

Saturation — (1) The condition of a liquid when it has taken into solution the maximum possible quantity of a given substance at a given temperature and pressure. (2) A condition in which the pressure of any fluid constituent is equal to its maximum value such that any increase will lead to condensation.

Saturation Curve — (Geology) A graph showing the weight of solids per unit volume of a saturated mass of soil in relation to its water content.

Saturation Deficit — The difference between the actual vapor pressure and the saturation vapor pressure as the existing temperature. Also referred to as the *Vapor Pressure Deficit*.

Saturation Mixing Ratio — The maximum water vapor concentration in the atmosphere for a given air temperature. The higher the air temperature, the higher the saturation mixing ratio.

Saturation Point — (1) That point at which a soil or an aquifer will no longer absorb any amount of water without losing an equal amount. (2) (Chemistry) The point at which a solution will receive no more of a certain solute under the given conditions.

Saturation Vapor Pressure — The maximum possible partial pressure of water vapor in the atmosphere at a given temperature.

Saturation, Zone of — The zone below the *Water Table* in which all pore spaces are filled with groundwater. The water table is

the top of the zone of saturation in an unconfined aquifer. Also referred to as the *Phreatic Zone*.

Saturator — A device which produces a fluoride solution for the fluoridation process. The device is usually a cylindrical container with granular sodium fluoride on the bottom. Water flows either upward or downward through the sodium fluoride to produce the fluoride solution.

Sault — A rapids or waterfall within a stream.

Sauna — (1) A Finnish steam bath in which the steam is produced by pouring water over heated rocks; a bathhouse or room for taking such a steam bath. (2) A dry heat bath; a room or an enclosure for taking a dry heat bath.

Sausage Dam — A dam composed of loose rock that has been wrapped with wire into cylindrical bundles and laid in a horizontal or vertical position.

Savanna, also Savannah — A flat grassland of tropical or subtropical regions dominated by grasses, sedges, and small shrubs with scattered trees, either as individuals or clumps. The savanna often represents a transitional region between true grassland and forest. Also see *Biome* and *Grasslands*.

Save-All Filter — A type of rotary filter used in pulp and paper mills for removing small amounts of fiber from large volumes of process and waste water.

Saxitoxin — The primary toxin produced by dinoflagellate protozoans during blooms known as *Red Tides* in marine waters. The genus or protozoan involved in the generation of the red color in the water is *Gonyaulax*. Also see *Paralytic Shellfish Poisoning*.

Scabland — (Geography) An elevated area of barren, rocky land with little or no soil cover, often crossed by dry stream channels.

Scald — (1) To burn with or as if with hot liquid or steam. (2) To subject to or treat with boiling water.

Scale — (1) An accumulation of solid material on interior surfaces, such as pipelines, tanks, and boilers, as a result of the precipitation of mineral salts from water, most typically salts of calcium. *Hard Water* leaves a deposit (scale) in steam irons, coffee makers, and water heaters. (2) A hard incrustation usually rich in sulfate of calcium that is deposited on the inside of a vessel (as a boiler) in which water is heated.

Scarify — In land *Restoration* activities, to stir the surface of the ground with an implement in preparation for replanting.

Scarp — (1) A line of cliffs produced by faulting or by erosion. The term is an abbreviated form of *Escarpment*, and the two terms commonly have the same meaning, although “scarp” is more often applied to cliffs formed by faulting. (2) A cliff, escarpment, or steep slope of some extent formed by a fault or a cliff or steep slope along the margin of a plateau, mesa, or terrace. (3) A relatively steep and straight, cliff-like face or slope of considerable linear extent, breaking the general continuity of the land by separating level or gently sloping surfaces lying at different levels, as along the margin of a plateau, mesa, terrace, or bench.

Scarp-Foot Spring — A spring flowing onto the surface of the land at or near the foot of an escarpment.

Scarp Stream — A stream flowing down a scarp in a direction opposite to that of the dip of the local strata.

Scattering Layer — (Oceanography) A mid-water layer of organisms that scatters sound and returns sonar echoes.

Scavenger Well — A well that is situated between a source of potential contamination and a well or wells that yield usable water, used to prevent the contaminated water from reaching the useful well or wells.

Scavenging Coefficient — The exponential constant (Λ) in an *Exponential Decay* model for the physical removal of particulate from the air by rainfall. Of the form:

$$X_t = X_0 e^{-\Lambda t}$$

where:

- X_t is the particulate concentration at time t ;
- X_0 is the particulate concentration at time 0;
- t is the number of time units (periods) since the rainfall began;
- e is the base of the natural logarithm; and
- Λ is the scavenging coefficient for the specific particulate.

SCBA — Self-Contained Breathing Apparatus. Also see *SCUBA*.

SCD — See *Soil Conservation District*.

Scenic Rivers — A classification under the national *Wild and Scenic Rivers Act* to include those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads. The following represents restrictions applying to such designated rivers:

- [1] **Timber Production** — A wide range of silvicultural practices could be allowed if such practices are carried on so that there is no substantial adverse effect on the river and its immediate environment. The river area should be maintained in its near natural environment. Timber outside the boundary but within the visual scene area should be managed and harvested in a way that provides special emphasis on visual quality.
- [2] **Water Supply** — All water supply dams and major diversions are prohibited.
- [3] **Hydroelectric Power** — No development of hydroelectric power facilities would be allowed.
- [4] **Flood Control** — Flood control dams and levees would be prohibited.
- [5] **Mining** — Subject to regulations (i.e., 36 CFR 228) that the Secretaries of Agricultural and Interior may prescribe to protect the values of rivers included in the national system. New mining claims and mineral leases could be allowed and existing operations allowed to continue. However, mineral activity must be conducted in a way that minimizes surface disturbances, sedimentation and pollution, and visual impairment.
- [6] **Road Construction** — Roads may occasionally bridge the river area and short stretches of conspicuous or longer stretches on inconspicuous and well screened roads or screened railroads could be allowed. Consideration will be

- given to the type of use for which roads are constructed and the type of use that will occur in the river area.
- [7] **Agriculture** — A wider range of agricultural uses is permitted to the extent currently practices. Row crops are not considered as an intrusion of the ‘largely primitive’ nature of scenic corridors if there is not a substantial adverse effect on the natural-like appearance of the river area.
 - [8] **Recreational Development** — Larger scale public use facilities, such as moderate size campgrounds, public information centers, and administrative headquarters are allowed if such structures are screened from the river. Modest and unobtrusive marinas also can be allowed.
 - [9] **Structures** — Any concentrations of habitations are limited to relatively short reaches of the river corridor. New structures that would have a direct and adverse effect on river values would not be allowed.
 - [10] **Utilities** — New transmission lines, gas lines, water lines, etc., are discouraged. Where no reasonable alternative exists, additional or new facilities should be restricted to existing right-of-way. Where new rights-of-ways are indicated, the scenic, recreation, and fish and wildlife values must be evaluated in the selection of the site.
 - [11] **Motorized Travel** — Motorized travel on land or water may be permitted, prohibited or restricted to protect the river values.

Also see *Wild and Scenic Rivers Act*, *Wild Rivers*, and *Recreational Rivers*.

Scenic Waterway — Rivers or river segments chosen for scenic and recreation qualities to be preserved in their natural state.

SCFM — Cubic feet of air per minute at standard conditions of temperature, pressure, and humidity (0 degrees Celsius/14.7 pounds per square inch atmospheric pressure /50 percent relative humidity).

Schedule of Compliance — Description of remedial actions to be accomplished by the permit holder (type of facility to be installed or alternative control measures to be established) and a sequence of actions leading to compliance with applicable standards.

Schedule, Pipe — A sizing system of arbitrary numbers that specifies the I.D. (inside diameter) and O.D. (outside diameter) for each diameter pipe. This term is used for steel, wrought iron, and some types of plastic pipe. Also used to describe the strength of some types of plastic pipe.

Scheduled Delivery — Operation of a water delivery system to meet predetermined needs, generally based on user water orders. Also referred to as *Arranged Delivery*.

Schist — A strongly foliated crystalline rock formed by dynamic metamorphism which can be readily split into thin flakes or slabs due to the well-developed parallelism of more than 50 percent of the minerals present.

Schistosome Cercariae — Aquatic larvae or parasitic trematode worms that penetrate the skin. Some species migrate via the lungs and the liver to the veins of the intestines and urinary bladder of the host. Other species become lodged in human skin, causing severe irritation (*Swimmer's Itch*). See *Schistosomiasis*.

Schistosomiasis — A debilitating tropical disease, common in underdeveloped regions of the world, particularly rural areas of Africa, Asia, and Latin America, caused by a small roundworm named *Schistosoma*. The disease is transmitted to humans through contact with water contaminated by fecal material. Infected humans discharge eggs in feces. These eggs hatch in freshwater, producing a small immature form of the parasite that infects snails common in streams, ponds, and lakes. The life cycle of the worm continues in the snail, and a second immature worm reenters the water where it later infects humans who come in contact with the infected water. Also referred to as *Bilharziasis* and *Snail Fever*.

Schmutzdecke — A layer of trapped matter at the surface of a slow sand filter in which a dense population of microorganisms develops. These microorganisms within the film or mat feed on and break down incoming organic material trapped in the mat. In doing so the microorganisms both remove organic matter and add mass to the mat, further developing the mat and increasing the physical straining action of the mat.

“Schmutzdecke” Layer — In slow sand filters used for water treatment, a biologically active bed of bacterial and algal slime that forms an effective barrier for very small particles, including bacteria and *oocysts*, even *cryptosporidial oocysts*.

Science Advisory Board (SAB) — An independent body established by the Administrator of the *U.S. Environmental Protection Agency (EPA)* in 1974 and by Congress in 1977. Its purpose is to review the scientific merits of EPA research and the scientific basis for the agency’s proposed regulations and standards.

Scientific Method — A systematic method of inquiry that includes the identification of a specific question or problem, the accumulation of the available data and information relating to that question, the proposal of a tentative answer or solution to the question or problem, the conduct of methodical observations or experiments to test the proposed answer, and the rational interpretation of the results of the observations or experiments.

Scooter — A sewer cleaning tool whose cleansing action depends on the development of high water velocity around the outside edge of a circular shield. The metal shield is rimmed with a rubber coating and is attached to a framework on wheels (like a child’s scooter). The angle of the shield is controlled by a chain spring system which regulates the head of water behind the scooter and thus the cleansing velocity of the water flowing around the shield.

Scour — (1) To clear, dig, or remove by or as if by a powerful current of water. (2) The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material. (3) The powerful and concentrating clearing and digging action of flowing air or water, especially the downward erosion by stream water in sweeping away mud and silt on the outside curve of a bend, or during time of flood. (4) A place in a stream bed swept (scoured) by running water, generally leaving a gravel bottom. (5) The process by which flood waters remove soil around objects that obstruct flow, such as the foundation walls of a house.

Scour and Fill — (Geology) A process in which the action of a stream or tide alternately excavates and refills a channel, particularly during a period of flooding.

Scouring Sluice — An opening in a dam controlled by a gate through which the accumulated silt, sand, and gravel may be ejected.

Scour Pools — A pool formed by flow directed either laterally or obliquely against a partial channel obstruction or bank.

- Screen** — (Wastewater Treatment) A device used to retain or remove suspended or floating objects in wastewater. The screen has openings that are generally uniform in size. It retains or removes objects larger than the openings. A screen may consist of bars, rods, wires, gratings, wire mesh, or perforated plates.
- Screening** — The use of screens to remove coarse floating and suspended solids from sewage.
- Scroll Meander** — A *Meander* in which the buildup of scrolls on the inner bank results in the lateral erosion of the outer bank, maintaining the width of the stream channel.
- Scrub** — (Ecology) A general term for any type of vegetation, such as evergreen shrubs or dwarfed trees, growing in areas with poor soil or low rainfall.
- Scrubber, Spray** — An air pollution control device that removes particulates or gases from an airstream by spraying liquid into the air duct and then collecting the pollutant-containing droplets. Also see *Spray Tower*.
- Scrubber, Venturi** — An air pollution control device that operates by the introduction of a liquid into a narrow throat section (venturi) of an air duct that is carrying a contaminant. The high velocity in the venturi, compared to the low initial liquid velocity, provides efficient contact between the injected scrubbing liquid and the contaminant to be removed.
- SCS** — Soil Conservation Service, renamed *Natural Resources Conservation Service (NRCS)*. An agency of the United States Department of Agriculture that provides technical assistance for resource conservation to farmers, other federal, state and local agencies, and to local soil conservation districts.
- SCUBA** — A portable apparatus containing compressed air and used for breathing under water. [The name is derived from S(elf-C(ontained)U(nderwater)B(reathing)A(pparatus).]
- Scud** — (1) Wind-driven clouds, mist, or rain; a gust of wind; ragged low clouds, moving rapidly beneath another cloud layer. (2) Small ragged low-cloud fragments that are unattached to a larger cloud base and often seen with and behind cold fronts and thunderstorm gust fronts.
- Scum** — (Biological) (1) A filmy layer of extraneous or impure matter that forms on or rises to the surface of a liquid or body of water. (2) A layer or film of foreign matter (such as grease, oil) that has risen to the surface of water or wastewater. A residue deposited on the ledge of a sewer, channel, or wet well at the water surface. A mass of solid matter that floats on the surface. The material which rises to the surface of a liquid and forms a layer or film on the surface. A scum layer forms on the water surface of a *Septic Tank*.
- Scupper** — (1) (Nautical) Openings along the side of a ship at deck level to allow water to run off. (2) An opening for draining off water, as from a floor or the roof of a building.
- S-Curve** — The mass curve corresponding to a *Unit Hydrograph* or a distribution graph.
- Scuttlebutt** — (1) A cask on shipboard to contain fresh water for a day's use. (2) A drinking fountain on a ship or at a naval or marine installation. (3) Slang term for rumor.
- SDWA** — See *Safe Drinking Water Act*.
- SDWA Amendment of 1986** — Addressed concerns about unregulated contaminants found in drinking water and contamination of groundwater by industrial solvents and pesticides. It also improved analytical techniques available for contaminant detection.
- Sea** — (1) One of the larger bodies of salt water, less than an ocean, more or less landlocked and generally forming part of, or connecting with, an ocean or a larger sea. (2) An inland body of water, especially if large or if salty or brackish.
- Sea Anchor** — A drag, typically made of canvas, thrown overboard to retard the drifting of a ship or seaplane and to keep its head (bow) pointed into the wind.
- Sea Breeze** — (1) A cooling breeze blowing generally in the daytime and inland from the sea. (2) The sea-to-land surface wind that typically occurs in coastal areas during the day. It is caused by the thermal rising of the air above the land, which warms more readily than the water. Also see *Land Breeze*.
- Sea Change** — A term once used to denote change brought about by the sea and its weather patterns.
- Sea Fire** — Marine bioluminescence.
- Sea Glow** — (Oceanography) The luminous cobalt-blue appearance of clear water in mid-ocean, resulting from absorption of much of the red spectrum in light reflected upward from below the surface.
- Sea Level** — (1) The level of the surface of the sea, especially measured at its mean position midway between mean high and low water. (2) Refers to the *National Geodetic Vertical Datum of 1929 (NGVD of 1929)* – a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Seal level Datum of 1929. Also see *Mean Sea Level (MSL)*.
- Sea Marsh** — (Ecology) A *Salt Marsh* that is periodically submerged by the sea. Also referred to as *Sea Meadow*.
- Sea Meadow** — See *Sea Marsh*.
- Sea Mile** — A unit of length used in sea and air navigation, based on the length of one minute of arc of a great circle, especially an international and U.S. unit equal to 1,852 meters (about 6,076 feet). More commonly referred to as *Nautical Mile*.
- Sea Stack** — A small, steep-sided rocky projection above sea level near a cliffed shore.
- Sea Wall, also Seawall** — An embankment to prevent erosion of a shoreline.
- Sea Wrack** — Seaweed, especially that material cast ashore in masses and clumps.
- Seabeach** — A beach lying along the sea.
- Seabed** — The floor of a sea or ocean.
- Seaboard** — Seacoast; also the country bordering a seacoast.
- Seaborne** — Borne or carried over or upon the sea.
- Seacoast** — The shore or border of the land adjacent to the sea.
- Seacock** — (Nautical) A valve in the hull of a boat or ship that may be opened to let in water so as to flood a ballast tank, for example.

Seadrome — A floating airdrome on water serving as an intermediate or emergency land place.

Seafloor — Same as *Seabed*.

Seagirt — Surrounded by the sea.

Seal — A tight and perfect closure as against the passage of water.

(Well) Seal — (Hydraulics) The watertight seal established in the annular space between the outermost water well casing and the drill hole to prevent the inflow and movement of surface water or shallow groundwater, or to prevent the outflow or movement of water under artesian pressures. The term also includes a *Sanitary Seal*.

Sealant — In retrofitting against the effects of flooding, a waterproofing material or substance used to prevent the infiltration of flood water.

Seaplane — An airplane designed to take off from and land on the water.

Seaport — A port, harbor, or town accessible to seagoing ships.

Seaquake — A submarine earthquake.

Seas (World) — The following constitute a listing of the principal seas of the world in alphabetical order: Adriatic Sea, Aegean Sea, Amundson Sea, Andaman Sea, Arabian Sea, Arafura Sea, Aral Sea, Baltic Sea, Banda Sea, Barents Sea, Bearing Sea, Beaufort Sea, Bellingshausan Sea, Bismark Sea, Black Sea, Caspian Sea, Caribbean Sea, Celebes Sea, Celtic Sea, Chukchi Sea, Coral Sea, Davis Sea, Dead Sea, D'Urville Sea, East China Sea, East Siberian Sea, Flores Sea, Greenland Sea, Halmahera Sea, Ionic (Ionian) Sea, Irish Sea, Java Sea, Kara Sea, Labrador Sea, Laptev Sea, Ligurian Sea, Mediterranean Sea, Molucca Sea, Norwegian Sea, North Sea, Philippine Sea, Red Sea, Ross Sea, Salton Sea, Savu Sea, Scotia Sea, Sea of Azov, Sea of Cortez, Sea of Crete, Sea of Galilee, Sea of Hebrides, Sea of Japan, Sea of Marmara, Sea of Okhotsk, Sibuyan Sea, South China Sea, Sulu Sea, Tasman Sea, Timor Sea, Tyrrhenian Sea, Weddell Sea, White Sea, Yellow Sea. Also see *Seven Seas*.

Seascape — A view of the sea; a picture representing a scene at sea.

Seashore — (1) Land by the sea. (2) A nationally-designated seashore, i.e., National Seashore. (3) (Legal) All the ground lying between the ordinary high-water and low-water marks; the *Foreshore*.

Season — A period of time characterized by some distinguishable occurrence or feature, such as growing season, harvest season, winter season, dry season, etc. It is not to be used in reference to a 12-month period.

Seasonal Adjustment — (Data Analysis) The adjustment of *Time-Series Data*, for example, commercial, residential, and irrigation water use, to eliminate the effects of intra-year normal variations (i.e., fluctuations within a 12-month period), such as those caused by weather patterns, agricultural cycles and irrigation patterns, school terms, holidays, and business patterns associated with such factors as product demand, tourism, etc. Also see *Seasonal Factors*.

Seasonal Adjustment Factors — (Data Analysis) Mathematical indexes used to adjust for the intra-year normal seasonal fluctuations in time-series data. In its simplest form, such indexes may be derived from dividing the value of each observation by a simple moving average centered over each data observation with such an average encompassing the six-month period before and after the observation. More sophisticated seasonal adjustment processes may also account for the placement of weekends and holidays and other factors affecting data behavior. Also see *Seasonal Factors*.

Seasonal Application Efficiency (SAE) — The sum of the *Evapotranspiration of Applied Water (ETAW)*, the *Leaching Requirement (LR)*, and cultural practices (CP) (e.g., frost protection, heat protection, weed control), divided by the total applied water (AW), expressed as a percentage, or,

$$SAE = (ETAW + LR + CP) / AW$$

Seasonal Factors — (Data Analysis) Factors such as weather conditions, agricultural production and irrigation requirements, business and tourism patterns, school schedules and holidays, etc., which cause normal annual fluctuations in business activity within individual and/or combinations of industries. These factors affect the demand for commercial, residential, and irrigation water use. Also see *Seasonal Adjustment* and *Seasonal Adjustment Factors*.

Seasonal (or Intermittent) Stream — (1) A stream that flows only during a certain climactic season. (2) A stream which flows only at certain times of the year when it receives water from springs, rainfall, or from surface sources such as melting snow. Also see *Stream*.

Seasonal Water Table — A groundwater table that has seasonal changes in depth or elevation.

Seasonality — (Statistics) Periodic, repetitive, and generally predictable patterns in time series data. Typically, forecast models must explicitly incorporate seasonality in the estimation process either through *Differencing* techniques (transformations), through the introduction of seasonal *Dummy Variables* to explicitly account for these patterns, or by seasonal smoothing (Winters Model).

Seasonally Adjusted (S.A.) — (Data Analysis) Data which have been adjusted (modified) by *Seasonal Adjustment Factors* so as to remove the effects of *Seasonality*. Also sometimes referred to as a *De-Seasonalization* of the data. Also see *Seasonal Adjustment*.

Seasonally Flooded (Estuarine) — Water regime in estuaries with seasonally-closed mouths and seasonally-flooded habitats.

Seasonal Wetlands — Wetland areas flooded or taking on the characteristics of a wetland only during specific periods of the year or seasons. Also see *Wetlands* and *Prairie Potholes*.

Seawater — The salt water in, or coming from the sea or ocean.

Seawater Intrusion — The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater basins.

Seawater Barrier — A physical facility or method of operation designed to prevent the intrusion of salt water into a body of freshwater.

Secchi Depth — A relatively crude measurement of the turbidity (cloudiness) of surface water. The depth at which a *Secchi Disc*

- (*Disk*), which is about 10-12 inches in diameter and on which is a black and white pattern, can no longer be seen.
- Secchi Disc (Disk)** — (1) A flat, white disc lowered into the water by a rope until it is just barely visible. At this point, the depth of the disc from the water surface is the recorded Secchi disc transparency. (2) A circular plate, generally about 10-12 inches (25.4-30.5 cm) in diameter, used to measure the transparency or clarity of water by noting the greatest depth at which it can be visually detected. Its primary use is in the study of lakes. Also see *Secchi Depth*.
- Second-Foot** — See *Second-Foot* and *Cubic Feet per Second*.
- Second-Foot** — In the United States, a unit of stream discharge equal to one cubic foot of water per second.
- Second-Foot Day** — A unit of runoff volume or reservoir capacity equal to a flow of one cubic foot per second for 24 hours, or a total of 86,400 cubic feet of water.
- Secondarily Improved Pastures** — Livestock pasture areas that have not been intensively land leveled or serviced by modern conveyance structures. These areas receive primarily drainage water from improved irrigated areas.
- Secondary (Indirect) Association** — (Statistics) A situation in which there exists an apparent link between two *Variables* that is actually the result of a *Confounding Variable*. When the confounding variable is controlled, then the link is no longer evident.
- Secondary Benefits** — The values over and above the immediate products or services of a water resource development project.
- Secondary Clarifier** — (Wastewater Treatment) A wastewater treatment device which consists of a rectangular or circular tank that allows those substances not removed by previous treatment processes that settle or float to be separated from the wastewater being treated.
- Secondary Consequent Stream** — (1) A tributary of a subsequent stream that developed after the subsequent stream, but which flows parallel to or down the same slope as the original consequent stream. (2) A stream flowing down the side of an anticline or syncline.
- Secondary Costs** — (FEMA) The cost associated with floodproofing activities, other than providing the basic floodproofing features, that are necessary to prevent a structure from being damaged by flooding.
- Secondary Data** — (Data Analysis) Typically, data acquired from published sources as opposed to data acquired from direct observation or measurement such as a survey. Contrast with *Primary Data*.
- Secondary Drinking Water Regulations** — Non-enforceable regulations applying to public water systems and specifying the maximum contamination levels that, in the judgement of the *U.S. Environmental Protection Agency (EPA)*, are required to protect the public welfare. These regulations apply to any contaminants that may adversely affect the odor or appearance of such water and consequently may cause people served by the system to discontinue its use. Term may be used synonymously with *Secondary Drinking Water Standards*.
- Secondary Drinking Water Standards** — Non-enforceable standards related to the aesthetic quality of drinking water such as those relating to taste and odor; generally set by the *U.S. Environmental Protection Agency (EPA)* or state water-quality enforcement agencies based on EPA guidance. Term may be used synonymously with *Secondary Drinking Water Regulations*. Also see *Drinking Water Standards*, *Drinking Water Standards [Nevada]*, *Water Contaminants*, *Water Treatment Disinfectants*, *Water Treatment Processes*, *Water Treatment Technologies*, *Water Quality Threats*, and *Waterborne Diseases*.
- Secondary Maximum Contaminant Level (SMCL)** — (1) Secondary MCLs are suggested maximum levels of contamination in water that affect the aesthetic quality of water. (2) The maximum concentration or level of certain water contaminants in public water supplies set by the *U.S. Environmental Protection Agency (EPA)* to protect the public welfare. The secondary levels are written to address aesthetic considerations such as taste, odor, and color of water, rather than health standards. Also see *Primary Drinking Water Standards*, *Maximum Contaminant Level (MCL)*, and *Maximum Contaminant Level Goal (MCLG)*.
- Secondary Porosity** — The porosity that results from fractures and solution channels.
- Secondary Recovery** — (1) The replenishment of *Groundwater* during and after the wet season, accompanied by a rise in the level of the *Water Table*. (2) The injection of water into an underground petroleum deposit to force the remaining oil into recovery wells. This technique is used to recover additional oil from old wells following the removal of the oil that can be easily pumped to the surface (*Primary Recovery*). Also referred to as *Enhanced Oil Recovery*. Also see *Injection and Recharge*.
- Secondary Settling Tank** — A tank used to hold wastewater that has been subjected to *Secondary Wastewater Treatment*. *Floc* or particles of organic matter formed during the secondary processes are allowed to settle from the suspension for subsequent removal.
- Secondary Standards** — Allowable amounts of materials in air or water that are set to retain environmental qualities not related to the protection of human health. Secondary water standards are set for, among other things, taste, odor, and color, and some secondary air standards define concentrations that will not be harmful to plant life. Compare to *Primary Standards*.
- Secondary Succession** — The orderly and predictable changes that occur over time in the plant and animal communities of an area that has been subjected to the removal of naturally occurring plant cover. This type of succession occurs when agricultural fields are taken out of use or when forested areas are subjected to severe fires that destroy all vegetation. In both cases the top soil remains for the regrowth of natural plant communities. Compare to *Primary Succession*.
- Secondary Treatment** — (Wastewater Treatment) (1) A wastewater treatment process used to convert dissolved or suspended materials into a form more readily separated from the water being treated. Usually the process follows primary treatment by sedimentation. The process commonly is a type of biological treatment process followed by *Secondary Clarifiers* that allow the solids to settle out from the water being treated. (2) A biological wastewater treatment process used to reduce the *Biochemical Oxygen Demand (BOD)* of organic dissolved or suspended materials in the wastewater being treated. Usually the process follows *Primary Treatment* by sedimentation. The process commonly is followed by secondary clarifiers that allow the solids to settle out from the wastewater being treated.
- Secondary Wastewater Treatment** — Treatment (following *Primary Wastewater Treatment*) involving the biological process of reducing suspended, colloidal, and dissolved organic matter in effluent from primary treatment systems and which generally

removes 80 to 95 percent of the *Biochemical Oxygen Demand (BOD)* and suspended matter. Secondary wastewater treatment may be accomplished by biological or chemical-physical methods. Activated sludge and trickling filters are two of the most common means of secondary treatment. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settleable solids and about 90 percent of the oxygen-demanding substances and suspended solids. Disinfection is the final stage of secondary treatment. Also see *Primary Treatment* and *Tertiary Wastewater Treatment*.

Secondary Wetlands [Lahontan Valley, Nevada] — Wetland habitat in the Environmental Impact Statement (EIS) study area that are not associated with Stillwater National Wildlife Refuge, Stillwater Wildlife Management Area, Carson Lake and Pasture, and the Fallon Indian Reservation. These areas are not part of the primary wetlands mandated to be sustained by *Public Law 101-618*.

Section — In a river system, a portion of river located between two points; a stretch or *Reach*.

Section — A unit of land area, generally equal to one square mile or 640 acres (259 hectares). Thirty-six sections also comprise a *Township* (6 miles long by 6 miles wide). The section is part of a description of the location of land using the survey system (*Public Land Survey System — PLSS*) of the United States Government and includes the 40-acre subdivision within a *quarter*, *section*, *township* and *range*. The public land survey system is based on the concept of a township as a square parcel of land six miles on each side. Its location is established as being so many six-mile units east of a north-south line (called the *meridian*) and so many six-mile units north or south of an east-west line (called the *baseline*). The township is described by township and range, e.g., T.4N, R.23E. Each township is further divided into 36 parts called sections one mile square (each section measuring 5,280 feet on each side). A typical section containing 640 acres may be further subdivided into quarters (measuring 2,640 feet on each side). The quarter of a section is equal to 160 acres and described as the NW¹/₄ or the NE¹/₄ or the SW¹/₄ or the SE¹/₄ of that particular section. The quarter section may be divided into four quarters, each being ¹/₁₆ of a section, or 40 acres (measuring 1,320 feet on each side). Each sixteenth is described as the NW¹/₁₆ or the NE¹/₁₆ or the SW¹/₁₆ or the SE¹/₁₆ of that particular quarter section. A person must determine which is north on a map (usually at the top) in this case the easterly direction would be to the right, south to the bottom, and west to the left. The written location of a specific 40-acre parcel of land would be NW¹/₄ of the NW¹/₄ of Section 13, T.4N., R.23E. Some sections may contain more or less acreage than 640.

Section 319 (Clean Water Act) — See *Clean Water Act (CWA)*, *Section 319*.

Section 404 (Clean Water Act) — That section of the *Clean Water Act (CWA)* delineating restrictions on the dredging and filling (only) of *Wetlands* in the United States. While *Section 404 Permits* are issued by the *U.S. Army Corps of Engineers (COE)*, Section 404 regulations are written by the *U.S. Environmental Protection Agency (EPA)*.

Section 404 Permit — The *Wetland* dredge and fill permit issued under regulations written to conform to *Section 404* of the *Clean Water Act (CWA)*. The permit is actually granted by the *U.S. Army Corps of Engineers (COE)*.

Secular Trend — (Data Analysis) A trend existing to some characteristic or phenomena over a relatively long period of time. Secular trends represent an important underpinning to any form of analysis as once such a trend is determined, deviations or perturbations from this trend may only be temporary and, if caused by man's activities, may not be reasonably sustainable in the long term.

Secure Landfill — (Water Quality) A ground location for the deposit of hazardous wastes. The material, either in solid or liquid form, is placed above natural and synthetic liners than prevent or restrict the *Leaching* of dangerous substances (*Leachates*) into the groundwater and deep aquifers. A piping network called a *Leachate Collection System* is placed beneath the facility to allow the pumped removal of any liquid that penetrates the bottom or side liners. Access to the location is restricted and wells are used to monitor the leaching of any dangerous materials into the surrounding area. May constitute a type of treatment, storage, or disposal facility.

Secure Maximum Contaminant Level — The maximum permissible level of a contaminant in water delivered to the free flowing outlet of the ultimate user, or of contamination resulting from corrosion of piping and plumbing caused by water quality.

Sediment — (1) Soil particles that have been transported from their natural location by wind or water action; particles of sand, soil, and minerals that are washed from the land and settle on the bottoms of wetlands and other aquatic habitats. (2) The soil material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by erosion (by air, water, gravity, or ice) and has come to rest on the earth's surface. (3) Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks; it also includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope, soil characteristics, land usage, and quantity and intensity of precipitation. (4) In the singular, the word is usually applied to material in suspension in water or recently deposited from suspension. In the plural the word is applied to all kinds of deposits from the waters of streams, lakes, or seas, and in a more general sense to deposits of wind and ice. Such deposits that have been consolidated are generally called sedimentary rocks. (5) Fragmental or clastic mineral particles derived from soil, alluvial, and rock materials by processes of erosion, and transported by water, wind, ice, and gravity. A special kind of sediment is generated by precipitation of solids from solution (i.e., calcium carbonate, iron oxides). Excluded from the definition are vegetation, wood, bacterial and algal slimes, extraneous light-weight artificially made substances such as trash, plastics, flue ash, dyes, and semisolids.

Sediment Basin — A man-made basin or intentional ponding area designed to hold storm water for a period of time to allow soil particles and other suspended material to settle. The water eventually flows out of the basin to downstream waterways, evaporates into the atmosphere or infiltrates the ground.

Sediment Charge — The ratio of the weight or volume of sediment in a stream to the weight or volume of water passing a given cross section of the stream per unit time.

Sediment Concentration — In a water-sediment mixture obtained from any body of water, the ratio of the dry weight of the

sediment to the total weight of the mixture.

Sediment Control — The control of movement of sediment on the land, in a stream or into a reservoir by means of manmade structures; such as debris dams, wing dams, or channelization; land management techniques, or natural processes.

Sediment (Catchment) Dam — A structure used specifically to trap sediment in water and prevent its transport further downstream.

Sediment-Delivery Ratio — (1) The ratio of sediment yield to gross erosion, expressed in percent. (2) (Geology) For a given drainage basin, the ratio of sediment yield to the entire amount of sediment transported by sheet and channel erosion, expressed as a percentage.

Sediment Deposition — The accumulation of soil particles on the channel bed and banks.

Sediment Deposition (SD) [Wetlands] — Refers to the volume of deposition and retention of inorganic and organic particulate from the water column, primarily through physical processes. A quantitative measure of this function would be expressed in centimeters per hectare per year (cm/ha/yr). The functional relationship for sediment deposition (SD) is calculated using:

$$SD = (V_{psc} + V_{fd} + V_{rough}) / 3$$

where:

V_{psc} — Represents the proximity of the wetland area to the source channel, thereby indicating the potential for sediment deposition, which decreases with increasing distance from the source of sediments. This relationship is likely to be a logarithmic one, since turbulent flow energy in tidal marsh canopies decays exponentially with increasing distance from the creek edge. A source channel is defined here as the nearest distributary channel, river, bay, or ocean.

V_{fd} — Represents the flooding duration, or the length of time during which the wetland or marsh surface is inundated, which has been demonstrated to affect sedimentation rates. The opportunity for particles to settle out of suspension increases with increasing flooding duration.

V_{rough} — Represents surface roughness, or the baffling effect of emergent marsh or wetland vegetation and microtopographic relief, which retards surface water flow, allows suspended particulate to settle out of suspension. Emergent macrophyte roots and rhizomes serve to stabilize sediments, reducing the potential for tidal re-suspension and transport. Algal mats on the surface of tidal wetlands also serve to bind sediments. In addition, filter-feeding bivalves remove sediment from overlying water and deposit it on the marsh surface as feces or pseudo-feces.

Sediment Deposits — See *Valley Sediment Deposits*.

Sediment Discharge — (1) Mass of sediment passing a stream cross-section at a defined unit of time. (2) The rate at which sediment passes a given cross section of a stream, measured by the dry weight or volume of sediment moved in a given time.

Sediment-Discharge Rating — The ratio between the discharge of sediment and the total discharge of the stream. Also referred to as *Sediment-Transport Rate*.

Sediment Discharge, Total — The rate at which dry weight of sediment passes a section of a stream or the quantity of sediment, as measured by dry weight or by volume, that is discharged in a given time. Typically reported in tons per day.

Sediment Discharge, Unmeasured — The difference between *Total Sediment Discharge* and measured *Suspended-Sediment Discharge*.

Sediment Load — (1) The soil particles transported through a channel by stream flow. (2) The solid material carried by a stream, expressed as the dry weight of all sediment that passes a given point over a given interval of time. (3) The total sediment, including bedload plus suspended sediment load, is the sediment being moved by flowing water in a stream at a specified cross section.

Sediment Load, Total — Also referred to as the total load, a term that refers to the total sediment (bed load plus suspended-sediment load) that is in transport. The term needs to be qualified, however, such as “annual suspended-sediment load” or “sand-size suspended-sediment load,” and so on. It is not synonymous with total sediment discharge.

Sediment Oxygen Demand (SOD) — The amount of dissolved oxygen removed from the water covering the sediment in a lake or stream because of microbial activity.

Sediment Pool — The reservoir space allotted to the accumulation of submerged sediment during the life of the structure.

Sediment Sequence and Composition (Geoindicator) [GCRIO] — The chemical, physical and biological character of aquatic sediments can provide a finely resolvable record of environmental change, in which natural events may be clearly distinguishable from human inputs. Lakes, wetlands, streams (and overbanks), estuaries, reservoirs, fjords, shallow coastal seas and other bodies of marine or fresh water commonly accumulate deposits derived from bedrocks, soils, and organic remains within the drainage basin, though fine particles can also be blown in by winds from distant natural, urban and industrial sources. These aquatic deposits may preserve a record of past or on-going environmental processes and components, both natural and human-induced, including soil erosion, air-transported particulates, solute transport, and landsliding. Some of these bodies of water are dynamic and sensitive systems whose sedimentary deposits preserve in their chemical, physical and biological composition a chronologically ordered and resolvable record of physical and chemical changes through their mineralogy, structure, and geochemistry (e.g., organic Carbon, biogenic silica, stable Oxygen isotopes in carbonates and cellulose, trace metals). Of particular value in determining long-term data on water chemistry are the remains of aquatic organisms (e.g., diatoms, chrysophytes, chironomids, and other algae and invertebrates) which can be correlated with various environmental parameters. In addition, fossil pollen, spores, and seeds reflect past terrestrial and aquatic vegetation. Sediment deposits can, thus, provide an indication of the degree and nature of impact of past events on the system, and a baseline for comparison with contemporary environmental change. Some lakes (and reservoirs) are open systems characterized by relatively stable shorelines and a limited residence time for solutes; others are closed (endorheic) and/or ephemeral (playas). Lake water solute concentrations may range

over five orders of magnitude from dilute, monsoonal rainwater to viscous chloride brines of 500,000 mg per kg; the pH may range from less than 2 in some sulphuric-acid rich Japanese crater lakes to more than 11 in alkaline brines of the East African rift. See *Geoindicators* [U.S. Global Change Research Information Office].

Sediment Station — A vertical cross section of a stream where load samples are collected systematically for the purpose of determining concentration and other characteristics.

Sediment Storage — The accumulation, in a reservoir, of sediment that would normally be carried downstream without the project.

Sediment Storage (Reservoir) — That portion of total reservoir storage dedicated for sediment deposition and encroachment. Normally a part of *Dead Storage*.

Sediment-Transport Curve — Usually the relation between water discharge and *Suspended-Sediment Discharge*, but it can be between water discharge and *Bed-Load Discharge*, *Unmeasured Sediment Discharge*, or *Total Sediment Discharge*.

Sediment-Transport Rate — See *Sediment-Discharge Rating*.

Sediment Yield — That amount of sediment transported by a stream system that may be measurable at a particular location. Usually expressed in volume or weight per unit of time.

Sedimentary Cycle — The biogeochemical cycle in which materials primarily are moved from land to sea and back again. See *Cycle of Sedimentation*.

Sedimentary Ripple — See *Ripple*.

Sedimentary Rock — (Geology) (1) Rocks formed by the accumulation of sediment in water (aqueous deposits) or from air (eolian deposits). A characteristic feature of sedimentary deposits is a layered structure known as stratification or bedding. (2) Rocks resulting from the consolidation of loose sediment that has accumulated in layers, especially from mechanical, chemical, or organic processes, and specifically: (a) clastic rock, such as conglomerate, sandstone, and shale, formed of fragments of other rock transported from their sources and deposited in water; and (b) rocks formed by precipitation from solution, as rock salt and gypsum, or from secretions of organisms, such as most limestone. Many sedimentary rocks show distinct layering, which is the result of different types of sediment being deposited in succession. Also see *Igneous Rock* and *Metamorphic Rock*.

Sedimentary Volcanism — (Volcanology) (1) The processes whereby, under pressure, a mixture of sediment, water, and gas is expelled, extruded, or breaks through overlying formations. (2) The processes whereby a sand or mud volcano is formed.

Sedimentation — (1) Strictly, the act or process of depositing sediment from suspension in water. Broadly, all the processes whereby particles of rock material are accumulated to form sedimentary deposits. Sedimentation, as commonly used, involves not only aqueous but also glacial, aeolian, and organic agents. Also see *Valley Sediment Deposits*. (2) (Water Quality) Letting solids settle out of wastewater by gravity during treatment. A water treatment process in which solid particles settle out of the water being treated in a large clarifier or sedimentation basin.

Sedimentation Analysis — (Chemistry) The examination of the rate at which solid particles in a suspension settle out, either by gravity or, more often, through the use of a strong applied force, as with a centrifuge; this permits the determination of both the average molecular weight of the solution and the molecular weight of its individual components.

Sedimentation Basin (SB) — A surface water runoff storage facility intended to trap suspended solids, suspended and buoyant debris, and adsorbed or absorbed potential pollutants that are carried by surface water runoff. The sedimentation basin may be part of an overall multipurpose detention and retention facility.

Sedimentation Tanks — Wastewater tanks in which floating wastes are skimmed off and settled solids are removed for disposal.

Sedimento-Eustasy — (Oceanography) A hypothetical state of equilibrium in the worldwide capacity of the ocean basins between the volume of sediment deposited and a possible increase in capacity due to local sinking of the sea floor caused by the weight of the sediment in some river deltas; in fact, the overall sedimentation rate is positive, but its effect on world sea level is considered to be minor in comparison to the effects of glacio-eustatic and tectono-eustatic changes.

Sediments — Soil, sand, and minerals washed from the land into water, usually after rain. They pile up in reservoirs, rivers, and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall.

Seep — (1) To pass slowly through small openings or pores; ooze. (2) Groundwater emerging on the face of a stream bank. (3) An area which slowly passes water out of the ground to the surface, or where water moves slowly from surface bodies to groundwater bodies, as from canals and ditches into the underlying groundwater table. (4) An area of minor groundwater outflow onto the land surface or into a stream channel or other water body. Flows are usually too small to be a spring.

Seepage — (1) The percolation of water through the soil from unlined channels, ditches, watercourses and water storage facilities. (2) The passage of water or other fluid through a porous medium, such as the passage of water through an earth embankment or masonry wall. (3) Groundwater emerging on the face of a stream bank. (4) The slow movement of water through small cracks, pores, *Interstices*, etc., of a material into or out of a body of surface or subsurface water. (5) The *Interstitial* movement of water that may take place through a dam, its foundation, or its *Abutments*. (6) The loss of water by infiltration into the soil from a canal, ditches, laterals, watercourse, reservoir, storage facilities, or other body of water, or from a field. Seepage is generally expressed as flow volume per unit of time. During the process of priming (a field during initial irrigation), the loss is called *Absorption Loss*.

Seepage Bed — A trench or bed more than 36 inches (0.91 meter) wide containing at least 12 inches (30.5 centimeters) of clean, coarse aggregate and a system of distribution piping through which treated sewage may seep into the surrounding soil.

Seepage Lake — (1) A lake whose ecology is determined primarily by groundwater rather than surface water. (2) A lake that has no surface outlet and that loses water mainly by seepage through the floor and walls of the lake's basin. (3) A lake receiving its water mainly from seepage.

Seepage Losses — A measure of water losses in a conveyance system due to water being seeped into the surrounding soils. Seepage losses from canals and other conveyance systems depend on: (1) the permeability of the surrounding soil; (2) the wetted surface

of the canal; and (3) the difference in level of the water in the canal and the adjacent groundwater table. Broadly, the seepage losses range from 15–45 percent of diverted flow for unlined canals and from 5–15 percent for lined canals.

Seepage Pit — A covered pit with lining designed to permit treated sewage to seep into the surrounding soil.

Seepage Spring — A spring having only a small yield. Also referred to as *Weeping Spring*.

Seeps — Groundwater/surface water connections caused by river or stream erosion into a near-surface aquifer.

Seiche — (1) An apparent tide in a lake due to pendulous motion of the water when excited by wind. (2) An oscillation of the water surface of a lake or other body of water due to variations of atmospheric pressure, wind, or minor earthquakes. The oscillation may be a foot or more in amplitude and may last several hours. (3) The pendulum-like movement of a body of water that continues after cessation of the originating force, which is usually wind, but may be other atmospheric phenomena or seismic disturbances. As an example, a tide is a special case of a seiche.

Sejunction Water — Capillary water completely surrounded by menisci and in static equilibrium within the soil above the *Capillary Fringe*.

Selective Ion Probe — An electrode for which the measured voltage is proportional to the concentration of a specific ion in the solution being tested. The most common example is the pH probe, which responds to the hydrogen ions in solution.

Selenium — A naturally-occurring inorganic element found primarily in soils, and to a lesser extent in water and air. Selenium is a necessary nutrient in very small amounts, but can be toxic in high doses.

Self-Produced Water — A water supply (usually from wells) developed and used by an individual or entity. Also referred to as *Self-Supplied Water*.

Self-Purification — The ability of a body of water to rid itself of pollutants. The removal of organic material, plant nutrients, or other pollutants from a lake or stream by the activity of the resident biological community. Biodegradable material added to a body of water will gradually be utilized by the microorganisms in the water, lowering the pollution levels. If excessive amounts of additional pollutants are not added downstream, the water will undergo self-cleansing. This process does not apply to pollution by non-biodegradable organic compounds or metals.

Self-Supplied Water — Water withdrawn from a surface or ground-water source by a user rather than being obtained from a *Public Water Supply System (PWSS)*. Also referred to as *Self-Produced Water*.

Self-Supplied Water (Industrial) — Water for industrial use, supplied from sources other than municipal distribution systems.

Selva — A dense tropical rain forest usually having a cloud cover, especially one in the Amazon Basin.

Semi-Bolson — A specific identification for an externally-drained *Intermontane Basin*.

Semi-Bolson Floor — A specific identification for the floor of a *Semi-Bolson* as compared with a *Bolson* floor.

Semi-Confined (Aquifer) — (1) An aquifer that is partially confined by a soil layer (or layers) of low permeability through which recharge and discharge can occur. (2) An aquifer that has a “leaky” confining unit and displays characteristics of both confined and unconfined aquifers, typically evidencing low permeability through which recharge and discharge can still occur. Also see *Leaky Aquifer*.

Semiaquatic — Adapted for living or growing in or near water; not entirely aquatic.

Semiarid — A term applied to regions or climates where moisture is normally greater than under arid conditions but still definitely limits the growth of most crops. Dryland farming methods or irrigation generally are required for crop production. The upper limit of average annual precipitation in the cool semiarid regions is as low as 15 inches (38.1 cm). Whereas in tropical regions it is as high as 45 or 50 inches (114.3 or 127.0 cm).

Semipermeable — (1) Partially permeable. (2) Allowing passage of certain, especially small, molecules or ions but action as a barrier to others. Used of biological and synthetic membranes.

Semipermeable Membrane — A barrier, usually thin, that permits passage of particles up to a certain size or of a special nature. Also referred to as a *Differentially Permeable Membrane* or simply *Membrane*.

Senescence (Senescent) — (Ecology) Describing plants or specific ecosystems that are nearing the end of their normal life span. Sometimes used to describe lakes or other bodies of water in advanced stages of *Eutrophication*. For example, a lake that is filling with accumulated aquatic vegetation, dead plant material, and sediments can be described as a *Senescent Lake* because it is nearing extinction as a productive lake environment. Also see *Secular Trend*.

Senescent Lake — A lake that is nearing extinction.

Senile — (Geology) Worn away nearly to the base level, as at the end of an erosion cycle.

Senior Rights — A senior rights holder is one who holds rights that are older (more senior) than those of junior rights holders. All water rights are defined in relation to other users, and a water rights holder only acquires the right to use a specific quantity of water under specified conditions. Thus, when limited water is available, senior rights are satisfied first in the order of their *Priority Date*.

Sensitive Species — (1) Those plant or animal species susceptible or vulnerable to activity impacts or habitat alterations. Species not yet officially listed but undergoing status review for listing on the *U.S. Fish and Wildlife Service's (USFWS)* official threatened and endangered list; species whose populations are small and widely dispersed or restricted to a few localities; and species whose numbers are declining so rapidly that official listing may be necessary. Also see *Endangered Species Act (ESA)*, *Endangered Species* and *Threatened Species*. (2) Those plant and animal species identified by a Regional Forester for which population viability is a concern as evidenced by: (a) significant current or predicted downward trends in population numbers or density; or (b) significant current or predicted downward trend in habitat capability that would reduce a species' existing distribution.

Sensor — An instrument that measure (senses) a physical condition or variable of interest. Floats and thermocouples are examples of sensors. Also called a *Primary Element*.

Septage — (1) The liquid and semisolid contents removed by pumping from a septic tank. (2) *Septic Tank* sludge that is a

combination of raw primary sludge and an anaerobically produced raw sludge.

Septic — A condition produced by bacteria when all oxygen supplies are depleted. If severe, bottom deposits and water turn black, give off foul odors, and the water has a greatly increased chlorine demand.

Septic System — An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank. The remaining solids must be pumped out periodically.

Septic Tank — (Wastewater Treatment) (1) A tank in which bacterial action is encouraged to break down sewage to harmless constituents. A sewage disposal tank in which a continuous flow of waste material is decomposed by anaerobic (in the absence of oxygen) bacteria. (2) A tank used to detain domestic wastes to allow the settling of solids prior to distribution to a leach field for soil absorption. Septic tanks and their associated *Leaching Fields* are used when a sewer line is not available to carry them to a treatment plant. A settling tank in which settled sludge is in immediate contact with sewage flowing through the tank, and wherein solids are decomposed by anaerobic bacterial action. Usually part of a rural on-site sewage treatment system. Typically, septic tanks would have a volume of 1–3 times the daily sewage flow. Also see *Septic System*. (3) A system sometimes used where wastewater collection systems and treatment plants are not available. The system is a settling tank in which settled sludge and floatable scum are in intimate contact with the wastewater flowing through the tank and the organic solids are decomposed by *Anaerobic* bacterial action. Used to treat wastewater and produce an effluent that flows into a subsurface leaching (filtering and disposal) system where additional treatment takes place. Also referred to as an *Interceptor*; however, the preferred term is septic tank.

Septic Tank Absorption Field — A soil absorption system for sewage disposal, consisting of a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the natural soil.

Septic Tank Effluent Filter (STEF) System — (Wastewater Treatment) A facility where effluent flows from a septic tank into a gravity flow collection system which flows to a gravity sewer, treatment plant or subsurface leaching system. The gravity flow pipeline is called an effluent drain.

Septic Tank Effluent Pump (STEP) System — (Wastewater Treatment) A facility where effluent is pumped from a septic tank into a pressurized collection system which may flow into a gravity sewer, treatment plant, or subsurface leaching system.

Septic Tank Soil Absorption System (ST–SAS) — A conventional wastewater treatment process used in isolated, rural, and other areas where normal sewer systems are not available whereby effluent is treated in a *Septic Tank*, then fed to soil-based disposal fields or trenches by gravity or under pressure. The quality of the ensuing filtration and absorption treatment is directly linked to soil and site characteristics such as permeability, drainage, slope, and depth to limiting conditions such as groundwater or bedrock. Unfortunately, many soils are classified as unsuitable for conventional soil absorption systems. Under such unsuitable soil conditions, alternative pretreatment systems may be employed to include sand filters, mound systems, evapotranspiration systems, low pressure pipe systems and a more complex drip soil absorption system. Also see *Drip (Trickle) Soil Absorption System*.

Septicity — (Wastewater Treatment) The condition in which organic matter decomposes to form foul smelling products associated with the absence of free oxygen. If severe, the wastewater produces hydrogen sulfide, turns black, gives off foul odors, contains little or no dissolved oxygen, and the wastewater has a high oxygen demand.

Sequencing Batch Reactors (SBR) — (Water Quality) A wastewater treatment technique consisting of an activated sludge system which operates sequentially in time rather than in space, that is, all steps of the process take place, one after the other, in the same tank instead of moving to a second tank for the continuation of the treatment. The typical SBR operation involves filling a tank with raw wastewater or primary effluent, aerating the wastewater to convert the organics into a microbial mass, providing a period for settling, discharging the treated effluent, and a period identified as “idle” that represents the time after discharging the tank and before refilling. Typically, a multiple tank system is required, allowing incoming flow to be switched to one tank while the other is going through the aeration, clarification, discharge, and idle functions. A key element of the SBR process is that a tank is never completely emptied, but rather a portion of settled solids is left in the tank for the next cycle. The retention of sludge within the tank establishes a population of microorganisms uniquely suited to treating the waste.

Sequestering Agent — (Water Quality) A chemical compound such as EDTA or certain polymers that chemically tie up (sequester) other compounds or ions so they cannot be involved in chemical reactions.

Sequestration — A chemical completing (forming or joining together) of metallic cations (such as iron) with certain inorganic compounds, such as phosphate. Sequestration prevents the precipitation of the metals (iron). Also see *Chelation*.

Sérac — (1) A large pointed mass of ice in a glacier isolated by intersecting crevasses. (2) A ridge, pinnacle, or irregular block of ice occurring on the surface of a glacier, usually at the intersection of crevasses, and formed by the breaking of the glacier as it passes over a steep slope.

Sere — A transitional stage in plant succession. Environmental conditions, species, or biotic communities may be described as seral in contrast to *Climax*.

Serial Distribution — An arrangement of *Absorption Trenches*, *Seepage Pits*, or *Seepage Beds* so that each is forced to pond, utilizing the total effective absorption area, before liquid flows into the succeeding component.

Serpulid Reefs — Calcareous reefs made up of tubes built by *tubicolous annelids* (worms) such as *Serpula*.

Service Area — The geographical land area served by a distribution system of a water agency.

Service Connector — The pipe that carries tap water from a public water main to a building.

Service Line Sample — A one-liter sample of water collected according to federal regulations (CFR Section 141.86(b)(6) of the Code of Federal Regulations) that has been standing for at least 6 hours in a service pipeline.

Service Pipe — The pipeline extending from the water main to the building served or to the consumer's system.

Seston — (1) All material, both organic and inorganic, suspended in a waterway. (2) (Oceanography) A collective term for the

suspended mineral matter, the living and dead animals, and the other organic debris found in the ocean.

Setback — Denotes the positioning of a levee or structure in relationship to a stream bank. A setback levee is placed a substantial distance from a stream to allow it to meander without consequences to the levee and to accommodate a floodplain that can store and convey flood flows. A setback regulation of a certain number of feet can be a requirement for the placement of urban buildings away from a stream-channel bank.

Settle — To cause to sink, become compact, or come to rest; to cause a liquid to become clear by forming a *Sediment*.

Settleable Solids — Most generally, all solids in a liquid that can be removed by stilling the liquid. In the *Imhoff* cone test, the volume of matter in a one-liter sample that settles to the bottom of the cone in one hour. (Water Quality) Bits of debris, sediment, or other solids that are heavy enough to sink when a liquid waste is allowed to stand in a pond or tank. Also see *Settling Chamber* and *Settling Pond*.

Settling Basin — An enlargement in the channel of a stream to permit the settling of materials carried in suspension.

Settling Chamber — (Water Quality) An enclosed container into which wastewater contaminated with solid materials is placed and allowed to stand. The solid pollutants suspended in the water sink to the bottom of the container for removal. Also referred to as a *Settling Tank*.

Settling Pond — (Water Quality) An open *Lagoon* into which wastewater contaminated with solid pollutants is placed and allowed to stand. The solid pollutants suspended in the water sink to the bottom of the lagoon and the liquid is allowed to overflow out of the enclosure.

Settling Tank — A term used synonymously with *Settling Chamber*.

Settling Velocity — (Fluid Mechanics) (1) The velocity at which suspended solid particles in a fluid precipitate or deposit. (2) The velocity at which a gas bubble, liquid droplet, or solid particle rises or falls in a fluid medium under the counteracting forces of gravity and drag. (3) (Water Quality) The rate of downward movement of particles through water. This gravitational settling removes particles naturally and is used also in pollution control devices, for example the *Settling Tanks* and *Ponds* in a sewage treatment facility. The settling velocity of a particle is often the same as the *Terminal Settling Velocity*.

Seven-Day 10-Year Low Flow (7Q10) — The period of lowest stream flow during a seven-day interval that is expected to occur once every 10 years. The 7Q10 has a 10-percent chance of occurring in any given year. During this time of low flow, the amount of *Dissolved Oxygen* in the water would be expected to be the lowest encountered under normal conditions. Since such conditions are considered to be the worst natural case, the dissolved oxygen levels during such episodes are used to establish *Ambient Water Quality Standards* for that stream.

Seven Seas — Figuratively, all the waters or oceans of the world. The phrase probably has its origins in Brahmanic mythology: the seven seas dividing and surrounding the seven land masses of the earth. In modern times it has been applied to the seven oceans: Arctic, Antarctic, North and South Atlantic, North and South Pacific, and Indian.

Severance (Water Rights) — The act of severing or separating water rights from the land. In most western states, water rights are considered attached to the land on which they are used. When land is sold, water rights automatically are transferred with the land to the new owner, unless such rights are specifically severed from the land by provisions of the deed.

Sewage — (1) The liquid waste from domestic, commercial, and industrial establishments. (2) The used water and solids that flow from homes through sewers to a wastewater treatment plant. The preferred term is *Wastewater*.

Sewage Fungus — A thick filamentous growth that develops in water contaminated with sewage. The filamentous material is composed predominately of the bacterium *Sphaerotilus natans*.

Sewage Lagoon — A shallow pond where natural processes are employed to treat sanitary waste from households or public rest rooms. Solid material settles to the bottom and is degraded by *Anaerobic* microbial communities. The enclosure is open to the atmosphere, which permits *Aerobic* mineralization of organic compounds in the upper layers of the water. The decomposition processes are analogous to those in effect in *Primary* and *Secondary Wastewater Treatment* processes. The effluent from these ponds is usually allowed to flow into nearby streams without further purification.

Sewage Sludge — Settled sewage solids combined with varying amounts of water and dissolved materials that are removed from sewage by screening, sedimentation, chemical precipitation, or bacterial digestion. The terms *Biosolids*, *Sludge*, and sewage sludge can be used interchangeably.

Sewage System — Pipelines or conduits, pumping stations, force mains, and all other structures, devices, and facilities used for collecting or conducting wastes to a point for treatment or disposal.

Sewage Treatment — The processing of wastewater for the removal or reduction of contained solids or other undesirable constituents.

Sewage Treatment Plant — A facility designed to receive the wastewater from domestic sources and to remove materials that damage water quality and threaten public health and safety when discharged into receiving streams or bodies of water. The substances removed are classified into four basic areas:

- [1] greases and fats;
- [2] solids from human waste and other sources;
- [3] dissolved pollutants from human waste and decomposition products; and
- [4] dangerous microorganisms.

Most facilities employ a combination of mechanical removal steps and bacterial decomposition to achieve the desired results. Chlorine is often added to discharges from the plants to reduce the danger of spreading disease by the release of pathogenic bacteria.

Sewage Treatment Return Flow — Water returned to the hydrologic system by a *Sewage Treatment Plant*.

Sewer — (1) The piping system or conduit used to carry runoff water or wastewater. (2) An underground system of conduits (pipes

and/or tunnels) that collect and transport wastewater and/or runoff; gravity sewers carry free-flowing water and wastes; pressurized sewers carry pumped wastewater under pressure; vacuum sewers create a negative pressure drawing wastewater to a collection tank for pumping. Various types of sewer systems fulfill different functions, for example:

- [1] **Sanitary Sewer** carries wastewater from a household or public facility;
- [2] **Storm Sewer** carries runoff from rainfall from streets and parking lots; and
- [3] **Combined Sewer** transports both rainfall runoff and sanitary waste.

Sewerage — The entire system of sewage collection, treatment, and disposal.

Sewerage System — The network of sewers that carries sewage from point of origin to point of treatment.

Shadoof (also Shaduf) — (1) A device consisting of a long suspended pole weighted at one end and having a bucket at the other end, used in the Near East and especially Egypt for raising water, as for the irrigation of land. (2) A counterbalanced sweep used since ancient times, especially in Egypt for raising water (as for irrigation).

Shaft — A vertical or inclined opening of uniform and limited cross section made for finding or mining ore, raising water, or ventilating underground workings (as in a cave).

Shale — A fine-grained sedimentary rock, formed by the consolidation of clay, silt, or mud. It is characterized by finely laminated structure and is sufficiently indurated so that it will not fall apart on wetting.

Shall — Indicates a requirement that is necessary or essential to meet the currently accepted standards of protection of Federal rules and regulations.

Shallow Water — Water of such limited depth that the bottom topography influences the formation of surface waves.

Shallow Well — (1) A water well that draws upon the shallowest *Aquifer* in the area. (2) A well having a low enough water level to permit the use of a suction pump. (3) A well with a pumping head of 20 feet or less, permitting use of a suction pump.

Shallows — An expanse of shallow water or a relatively shallow place in a lake, stream, or other body of water.

Sharp-Crested Weir — A device for measuring water, featuring a notch cut in a relatively thin plate and having a sharp edge on the upstream side of the crest.

Shear — A force parallel to a surface as opposed to directly on the surface. An example of shear would be the tractive force that removes particles from a stream bank as flow moves over the surface of the slope; a floating log that directly strikes the bank would not be a shear force.

Sheet — (Geology) A broad, relatively thin deposit or layer of *Igneous* or *Sedimentary Rock*.

Sheet Erosion — (1) The removal of thin, fairly uniform layer of soil or materials from the land surface by the action of rainfall and runoff water. (2) The removal by surface runoff of a fairly uniform layer of soil from a bank slope from *Sheet Flow* or runoff that flows over the ground surface as a thin, even layer not concentrated in a channel.

Sheet Flood (also Sheetflood) — (1) A short-duration flood that spreads over a large area as a thin, continuous film, rather than being concentrated in well-defined channels. (2) A broad expanse of moving, storm-borne water that spreads as a thin, continuous, relatively uniform film over a large area in an arid region and that is not concentrated into well defined channels; its distance of flow is short and its duration is measured in minutes or hours. Sheetfloods usually occur before runoff is sufficient to promote channel flow, or after a period of sudden and heavy rainfall.

Sheet Flow (also Sheetflow) — (1) The downslope movement of surface runoff over relatively smooth land surfaces in the form of a thin, continuous film that is not concentrated in channels. (2) An overland flow or downslope movement of water taking the form of a thin, continuous film over relatively smooth soil or rock surfaces and not concentrated into channels larger than rills.

Sheetflow (Sheet Flow) Area — Designated *Flood Zones* AO and AH on a community's *Flood Insurance Rate Map (FIRM)* with a one percent or greater annual chance of flooding to an average depth of one to three feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet flow. Also referred to as *Area of Shallow Flooding*.

Sheet Piling — Material, typically concrete or steel, placed vertically in the ground to contain erosion or the lateral movement of groundwater.

Sheldon National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Sheldon NWR is located in the northwestern corner of Nevada and consists of over 575,000 acres (approximately 900 square miles) of high-desert habitat as a representative area for native plants and wildlife. The Sheldon NWR was formally established in 1978 and represented a consolidation of two refuge and range protection areas: (1) the Charles Sheldon Wildlife Range, created in 1931 by President Herbert Hoover from the purchase of the 30,000-acre Last Chance Ranch by the Boone and Crockett Club and the National Audubon Society; and (2) the Charles Sheldon Antelope Range, an area of over one-half million acres created in 1936 by President Franklin D. Roosevelt for the conservation and development of natural wildlife resources. Today, this area encompasses remote settings, scenic vistas, numerous natural geothermal hot springs, old ranches and homesteads plus sites of archaeological significance. Some 20 million years ago this area was covered with pine forests and lush grasslands, nurtured by a mild climate and more than 50 inches of annual rainfall. Today, this area receives only from 4–8 inches of precipitation, primarily in the form of snowfall, and the prominent geological characteristic of this refuge is the subsequent volcanic activity which spewed rhyolitic magma over much of its area with basalt flows up to 100 feet thick. These have formed the large, broad tables prevalent in this area today. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Shelf Cloud — A low, horizontal wedge-shaped arcus cloud associated with a thunderstorm gust front and attached to the thunderstorm base.

Shelf Ice — An extension of glacial ice into coastal waters that is in contact with the bottom near the shore but not toward the outer

edge of the shelf.

Shifting Control — A stream-gaging control which is affected by scour, fill, or backwater.

Shigella Dysenteriae — A waterborne microorganism which is the causative agent of bacillary dysentery, a disease characterized by severe diarrhea with blood and pus in the feces. The disease is transmitted through the consumption of water, food, or beverages contaminated with fecal material.

Shoal — (1) A shallow place in an ocean, lake, stream, or other body of water. (2) A sandy elevation of the bottom of a body of water, constituting a hazard to navigation. (3) A sandbank or sandbar that makes the water shallow; specifically an elevation which is not rocky and on which there is a depth of water of six fathoms (11 meters or 36 feet) or less. Also referred to as a *Sandbank* or *Sandbar*.

Shoal Patches — (Oceanography) Irregularly scattered elevations of the bottom, at depths of 10 fathoms (18 meters) or less, composed of materials other than coral or rock.

Shoal Water — (Oceanography) Shallow water; water in which the bottom is 10 fathoms (18 meters) deep or less.

Shoaling — (Oceanography) The effect of the bottom on deep-water waves as they approach the shore, including an initial decrease in wave height followed by a rapid increase before the wave breaks.

Shock Load — (Water Treatment) The arrival at a water treatment plant of raw water containing unusual amounts of algae, colloidal matter, color, suspended solids, turbidity, or other pollutants. The arrival at a plant of a waste which is toxic to organisms in sufficient quantity or strength to cause operating problems. Possible problems include odors and sloughing off of the growth or slime on the trickling filter media. Organic or hydraulic overloads also can cause a shock load.

Shoot — (1) A rush of water down a steep or rapid. (2) A place where a stream runs or descends swiftly. (3) A natural or artificial passageway through which water moves to a lower level. (4) A rapids or a rush of water down a steep slope. (5) To cause to move suddenly or swiftly forward as motion down rapids.

Shorebird — One of several families of often long-legged wading birds that inhabit the seacoast and shallow fresh-water bodies including sandpipers, stilts, killdeer, avocets, plovers and others.

Shorefront — Land situated on the edge of a body of water.

Shore Life — The essentially marine organisms that inhabit the region bounded on one side by the height of the extreme high tide and on the other by the height of the extreme low tide. Within these boundaries, organisms face a severe environment imposed by the rise and fall of tides. For up to half of a 24-hour period, the environment is marine; the rest of the time it is exposed, with terrestrial extremes in temperature and the drying effects of wind and sun. Life on rocky shores, best developed on northern coasts, is separated into distinct zones that reflect the length of time each zone is exposed. At the highest position on the rocks is the so-called black zone, marked by encrusted bluegreen algae. This transition area between land and the marine environment is flooded only during the high spring or fortnightly tides. The algae, enclosed in gelatinous sheaths to resist drying, are grazed on by periwinkles, which are protected under tightly sealed, conical shells. Below the black zone lies a so-called white zone, where barnacles are tightly glued to rocks. Living among the barnacles are rock-clinging mollusks called limpets. At low tide, barnacles keep their four movable plates closed to avoid drying; at high tide they open the plates and extend six pairs of wand-like tentacles to sweep the water for microscopic life. Preying on the barnacles are hole-drilling snails called dog whelks. Below the white zone and in some places overlying the barnacles are rockweeds, which have no roots but are attached to rocks by holdfasts. Brown algae (*Phaeophyta*) are rockweeds that grow more than 8 feet (2.5 meters) long; the most common are the bladder wracks, with branching thalli up to 6 inches (15 centimeters) wide. Looking like fronds, the thalli have conspicuous, bubble-like swellings that buoy the plants at high tide. Blue mussels also inhabit this tide zone, especially where sediment accumulates. They attach themselves to the substrate by threadlike byssuses secreted by a gland in the foot. In the lowest zone, uncovered only during the spring tides, is the large brown alga *Laminaria*, one of the kelps. Beneath its frond-like thalli live starfish, sea cucumbers, limpets, mussels, and crabs. Also see *Marine Life*.

Short-Circuiting — (Water Quality) A condition that occurs in tanks or basins when some of the water travels faster than the rest of the flowing water. This is usually undesirable since it may result in shorter contact, reaction, or settling times in comparison with the theoretical (calculated) or presumed detention times.

Should — Indicates an advisory recommendation that is to be applied when practicable.

Shoulder — The convex slope component at the top of an erosional *Sideslope*.

Shower — A brief fall of precipitation, such as rain, hail, sleet, or snow.

Showerhead — A fixture for directing the spray of water in a bathroom shower.

Shrink-Swell Potential — The susceptibility of soil to volume change due to loss or gain in moisture content.

Shrub — A woody plant which at maturity is usually less than 6 m (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance; e.g., speckled alder (*Alnus rugosa*) or buttonbush (*Cephalanthus occidentalis*).

Shrund — See *Bergschrund*.

S-Hydrograph — The direct surface discharge hydrograph resulting from a continuous succession of *Unit Storms*.

SIC Code — See *Standard Industrial Classification (SIC) Code*.

Side Curler — Within a river system, a reversal parallel to the main current, formed by a side current passing over a rock as it enters the main channel.

Side Moraine — See *Lateral Moraine*.

Sideslope — The erosional slope around the sides of an erosional fan remnant, hill, ballena, mountain, etc., that is composed of shoulder, backslope, footslope and perhaps toeslope components. Also, the planimetrically-linear portions of the slopes around a digitately-dissected fan remnant or hill, etc., as compared with the planimetrically-convex noseslope and concave headslope portions.

Sidestream — See *Tributary*.

(The) Sierra Club — A national environmental organization founded in 1892 based in San Francisco, California. The Sierra Club is dedicated to the exploration, enjoyment, and protection of the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to accomplish these objectives. The Sierra Club is active in public education, lobbying of legislative and administrative bodies, and, through *Earthjustice* (formerly the *Sierra Club Legal Defense Fund*), in the courts.

Sierra Club Legal Defense Fund — See *Sierra Club* and *Earthjustice*.

Sierra Valley Decree [California–Nevada] — Adjudication (1958) allowing the Sierra Valley Water Company to divert a portion of the Little Truckee River in California into Webber Creek for irrigation purposes in the Sierra Valley in the Feather River Basin. The maximum allowable diversion is 60 cubic feet per second (cfs), averaging approximately 5,700 acre-feet (AF) per year (although as a supplemental water source, diversions typically vary between 1,500 AF and 10,000 AF per year). Waters may be diverted only between March 15th and September 30th of each year. The *Priority Date* of this water right was set at 1870.

Sierra Wave [Sierra Nevada] — The condition along the eastern slope of the Sierra Nevada range in California and Nevada which manifests itself in the creation of *Lenticular Clouds*. This condition is facilitated by the north-south orientation of the mountains and the prevailing westerly winds, providing ideal conditions for the formation of such clouds. The condition is most prevalent in the winter months when the jet stream reaches further south. The resultant lenticular clouds typically form at between 20,000 and 25,000 feet and appear as flat or elongated clouds which appear “trapped” beneath the rising and falling air stream over the mountains. In fact, the stationary effect is an optical illusion; the lenticular cloud is actually forming on its front edge and vanishing on its trailing edge.

Sieve Analysis — Determination of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

Sigmoid Growth — (Data Analysis) A growth rate trend characterized by an elongated S-shaped, or sigmoid curve. Typical of population growth rate trends which begin rapidly at an exponential rate but slow as limiting factors are encountered until a limit is approached asymptotically. Also see *Arithmetic Growth*, and *Exponential Growth*.

Significant (Statistical) — A term applied to differences, correlations, cause-and-effect relationships, etc., to indicate that they are probably not due to chance alone. Significant ordinarily indicates a probability of not less than 95 percent, while highly significant indicates a probability of not less than 99 percent.

Significant Hydrologic Resources (SHR) — As part of a planning or resource inventory process, generally refers to either federally significant water-related resources, e.g., wetlands, which meet federal definitions and guidelines, or regionally designated significant resources which do not meet such federal definitions or guidelines, e.g., stream and riparian environments, playas, spring fed stands of riparian vegetation, and other wetland areas.

Significant Industrial User (SIU) — (Wastewater Treatment) A significant industrial user includes:

- [1] All categorical industrial users, and
- [2] Any noncategorical industrial user that (a) discharges 25,000 gallons per day or more of process wastewater (“process wastewater” excludes sanitary, noncontact cooling and boiler blowdown wastewaters), or (b) contributes a process wastestream which makes up five percent or more of the average dry weather hydraulic or organic (*Biochemical Oxygen Demand*, *Total Suspended Solids*) capacity of a treatment plant, or (c) has a reasonable potential, in the opinion of the Control or Approval Authority, to adversely affect the *Privately Owned Treatment Works (POTW)* treatment plant (inhibition, pass through of pollutants, sludge contamination, or endangerment of POTW workers).

Significant Municipal Facilities — Those publicly owned sewage treatment plants that discharge a million gallons per day or more and are therefore considered by states to have the potential to substantially effect the quality of receiving waters.

Silica — (Geology) Silicon dioxide (SiO₂). It occurs in crystalline (quartz), amorphous (opal), or impure (silica sand) forms.

Sill — (1) A submerged ridge at relatively shallow depth separating the basins of two bodies of water. (2) A horizontal beam forming the bottom of the entrance to a lock. (3) Also, a low, submerged dam-like structure built to control riverbed scour and current speeds.

Silt — (1) Sedimentary particles smaller than sand particles, but larger than clay particles. (2) An intermediate soil textural class consisting of particles between 0.05 and 0.002 millimeters in diameter.

Siltation — The deposition of finely divided soil and rock particles upon the bottom of stream and river beds and in reservoirs.

Silting — Silting takes place when the pressure of infiltrating waters is great enough to carry silt, sand and other small particles from the soil into the sewer system. Where lower velocities are present in the sewer pipes, settling of these materials results in silting of the sewer system.

Silver Iodide — A compound of silver and iodine, the crystalline structure of which closely approximates that of ice crystals; used as ice nuclei in weather modification.

Silver Iodide Generator — Any of several devices used to generate a smoke of *Silver Iodide* crystals for *Cloud Seeding*.

Silver Iodide Seeding — A method of *Cloud Seeding* in which *Silver Iodide* crystals are introduced into the supercooled portions of clouds to induce the *Nucleation* of ice crystals and, thus, precipitation.

Silvics — (1) The science treating of the life of trees in the forest. (2) Habit or behavior of a forest tree.

Silviculture — (1) The art of producing and caring for a forest. (2) The cultivation of forest trees; forestry.

Simple Regression (Model) — (Statistics) A model structure characterized by only one explanatory (*Exogenous*) variable, of the form:

$$Y_t = \alpha + \beta X_t + \epsilon_t$$

where:

t represents the time periods of observation (where $t=1, 2, \dots, n$);

Y_t represents the dependent (*Endogenous*) variable in time period t ;

α (*alpha*) represents the model equation's constant term (without a time reference);

β (*beta*, also a constant term without a time reference) represents the coefficient of the independent variable;

X_t represents the independent variable in time period t ; and

ϵ_t (*epsilon*), the error term, represents the value of the unexplained disturbance term.

Also see *Multiple Regression (Model)*.

Simulate — To reproduce the action of some process, usually on a smaller scale.

Simulation Analysis — (1) (General) A method by which various changes to input factors are tested in their effects on certain outputs within a modeling environment, i.e., the use of an econometric forecasting model, simulation analysis, or some other structured analytical framework. (2) (Statistics) A procedure or process by which an *Econometric Model (Regression Analysis)* is designed to test the effects on outputs of various changes (simulations) of inputs. Simulations of a model might be performed for a variety of reasons, including model testing and evaluation, historical policy analysis, and forecasting. Simulation may be *ex post*, or simulation beyond the estimation period of the model but for periods of time for which actual data is available for validation purposes. Simulation may also be *ex ante* which includes forecasting beyond the last actual data point. Therefore, forecasting represents a form of simulation of an econometric model forward in time beyond the model's estimation period.

Single and Complete Project [USACE] — The term "single and complete project" is defined at 33 Code of Federal Regulations (CFR) 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers (see definition of independent utility). For linear projects the "single and complete project" (i.e., a single and complete crossing) will apply to each crossing of a separate water of the United States (i.e., a single waterbody) at that location. An exception is for linear projects crossing a single waterbody several times at separate and distant locations: each crossing is considered a single and complete project. However, individual channels in a braided stream or river, or individual arms of a large, irregularly-shaped wetland or lake, etc., are not separate waterbodies.

Single-Stage Pump — A pump that has only one impeller. A multi-stage pump has more than one impeller.

Sink — (1) Generally, a dry or intermittently dry lakebed in the lowest spot of a closed valley; a depression in the land surface, especially one having a central playa or saline lake with no outlet. Salt contents are generally quite high. The term sink is interchangeable with the term *Playa*. Also see *Natural Sink*. (2) (Environmental) A place in the environment where a compound or material collects.

Sinkhole — (1) A closed depression resulting from solution or collapse in areas of limestone bedrock. Synonym for *Sink*. (2) A depression in the earth's surface caused by dissolving of underlying limestone, salt, or gypsum. Drainage is provided through underground channels which may be enlarged by the collapse of a cavern roof. Also see *Karst*.

Sinking — (Environmental) Controlling oil spills by using an agent to trap the oil and sink it to the bottom of the body of water where the *Sinking Agent* and the oil are biodegraded.

Sinking Agent — A chemical additive that, when applied to a floating oil discharge, will cause oil to sink below the surface of the water. The application of sinking agents is generally not permitted by regulations of the *U.S. Environmental Protection Agency (EPA)* governing the treatment of oil discharges.

Sinking Stream — A surface stream that disappears underground. Also referred to as *Lost Stream* or *Disappearing Stream*.

Sinter — A chemical sedimentary rock deposited as a hard incrustation on rocks or on the ground by precipitation from hot or cold mineral waters of springs, lakes, or streams.

Sinuuous (Stream) — Characterized by many curves or turns; winding. See *Sinuosity*.

Sinuosity (Average) — (1) (General) The nature of a meandering and winding stream system. (2) (Measured) The ratio of the *Thalweg* length (i.e., the line connecting the deepest points along a stream) to valley length, for a specific reach of a river or stream system. This is, in essence, a ratio of the stream's actual "running" length to its down-gradient length.

Sinuosity Ratio — The ratio between the channel distance and the valley distance or the valley and channel slopes. Using the ratio of channel distance to valley distance, sinuosity ratios of 1.0-1.2 are typically considered as evidencing minor meandering, ratios of 1.2-1.5 show appreciable meandering, and a ratio greater than 1.5 is considered to be severe meandering. Also referred to as the *Tortuosity Ratio*.

Siphon, also Syphon — (1) A pipe or tube fashioned or deployed in an inverted U shape and filled until atmospheric pressure is sufficient to force a liquid from a reservoir in one end of the tube over a barrier higher than the reservoir and out the other end. (2) A pipe or conduit through which water will flow above the *Hydraulic Grade Line (HGL)* under certain conditions. Water (or other liquid) is first forced to flow or is sucked or drawn through the pipe by creation of a vacuum. As long as no air enters the pipe to interrupt flow, atmospheric pressure on the liquid at the elevated (higher) end of the siphon will cause the flow to continue. (3) (Zoology) A tubular organ, especially of aquatic invertebrates such as squids or clams, by which water is taken in or expelled.

Siphon Tubes — (Irrigation) Small curved pipes, typically 0.5–4.0 inches (1.3–10.2 centimeters) in diameter, that deliver water over the side of a head ditch or lateral to furrows, corrugations, or borders.

Site — (Environmental) An area or place within the jurisdiction of the *U.S. Environmental Protection Agency (EPA)* and/or a state.

(Local Test-Well) Site Designation [Nevada] — The local test-well site designation used in Nevada is based on the identification of a site by hydrographic area and by the official rectangular subdivision of the public lands referenced to the Mount Diablo

(located east of Walnut Creek, California) base line and meridian and is based on the *Public Land Survey System (PLSS)*. Each site designation consists of four units: The first unit is the hydrographic area number. The second unit is the township, preceded by an N or S to indicate location north or south of the base line. The third unit is the range, preceded by an E to indicate location east of meridian. The fourth unit consists of the section number and letters designating the quarter section, quarter-quarter section, and so on (A, B, C, and D indicate the northeast, northwest, southwest, and southeast quarters, respectively), followed by a number indicating the sequence in which the site was recorded. For example, site 210 S12 E63 29DABC2 is in Coyote Spring Valley (Nevada Hydrographic Area 210). It is the second site recorded in the southwest quarter (C) of the northwest quarter (B) of the northeast quarter (A) of the southeast quarter (D) of Section 29, Township 12 South, Range 63 East, Mount Diablo base line and meridian.

(Test-Well) Site Identification [USGS] — The standard *U.S. Geological Survey (USGS)* site identification is based on the grid system of latitude and longitude. The number consists of 15 digits. The first six digits denote the degrees, minutes, and seconds of latitude; the next seven digits denote degrees, minutes, and seconds of longitude; and the last two digits (assigned sequentially) identify the sites within a 1-second grid. For example, site 365227114554401 is at 36E52N270 latitude and 114E55N440 longitude, and it is the first site recorded in that 1-second grid. The assigned number is retained as a permanent identifier even if a more precise latitude and longitude are later determined. Also see *Local Site Designation [Nevada]*.

SI Units — The *International System of Units (Le Système International d'Unités)* defined by an international gathering convened to establish agreements on the most frequently used units of measurement. The *Conference on Weights and Measures* in 1960 adopted standard measures based on the meter/kilogram/second units and radiation quantities based on the becquerel, gray, and sievert. The units adopted by the conference represent the currently preferred measures of length, mass, time, radiation, and so on.

Skerry — (Scandinavian) A rocky isle; a reef.

Skim — (1) To remove floating matter from the surface of a liquid. (2) To throw in a gliding path; especially to throw so as to ricochet along the surface of water.

Skimming — (1) The diversion of water from a stream or conduit by a shallow overflow in order to avoid diversion of sand, silt, or other debris carried as bottom load. (2) Using a machine to remove oil or scum from the surface of the water.

Skin Diving — The sport of swimming under water with a face mask and flippers and especially without a portable breathing device.

Skin Sample — Sampled water that is not representative of the cross-sectional flow in a pipe or conduit. A skin sample can result if the tap opens on the inside wall of the pipe and can be avoided by using sampling taps that extend toward the center of the pipe, away from the wall.

Slack Tide — See *Slack Water*.

Slack Water — (1) (Hydrology) A quiet or still part of any normally active body of water, such as the inside of a bend in a river, where the current is slight. (2) (Oceanography) The period when a tidal current's speed is near zero, so that there is little or no horizontal movement of water; usually occurring between ebb and flood. Also referred to as *Slack Tide*.

Slackwater Channel — A navigation channel in a canal or river where the water surface elevation is controlled by a dam or dams with locks.

Slake — (1) To satisfy (a craving) as to quench a thirst. (2) To cool or refresh by wetting or moistening. (3) To become mixed with water so that a true chemical combination (hydration) takes place, as in the slaking of lime.

Slack Water — (1) A quiet or still part of any normally active body of water, such as the inside of a bend in a river, where the current is slight. (2) (Oceanography) The period when a tidal current's speed is near zero, so that there is little or no horizontal movement of water. Usually this phenomenon occurs between ebb and flood tides.

Slaked Lime — Calcium hydroxide which is formed by the addition of water to quicklime; a process termed *Slaking*.

Slaker — A mechanical device in which dry lime (calcium oxide) or magnesium oxide is powdered and mixed with water to produce alkali consisting of calcium or magnesium hydroxide. Calcium hydroxide is used as a water softener.

Slash and Burn — (Environmental) An agricultural practice involving the rapid destruction of natural forest for limited farming activity. The natural forest is cleared, the residue from the clearing process is burned, and crops are planted for a few years. When the fertility of the soil is depleted, the process is repeated in a new area, and the initial land is abandoned.

Sleeper — In a river system, a submerged rock or boulder just below the surface, usually marked by little or no surface disturbance.

Sleet (Ice Pellets) — (1) A form of precipitation consisting of frozen raindrops cooled to the ice stage while falling through air at subfreezing temperatures. (2) Rain combined with snow or hail. (3) A thin icy coating that forms when rain or sleet freezes, as on trees or streets. (4) Solid grains of transparent or translucent ice formed by the freezing of raindrops or the refreezing of melted snowflake. Sleet typically bounces upon impact with the ground.

Slick — A smooth, glassy streak or patch on the water's surface; usually caused by an almost undetectable film of organic material on the surface. Temporary slicks may also be caused by objects in the water, such as a turning ship.

Slickensides — (Geology) A smooth striated polished surface produced on rock by movement along a fault.

Slick Spots — Barren areas having puddled or crusted, very smooth, nearly impervious surfaces, usually because of high salinity or alkalinity.

Slickens — A term used to describe the result of hydraulic mining activities and the resulting debris, mud, and silt which tended to clog streams and fill in river beds, causing the water to overflow the banks and seek new channels, generally with detriment consequences on human activities downstream.

Slide — The descent of a mass such as earth, rock, or snow, down a hill or mountainside. A landslide.

Slimes — (Water Quality) Substances of viscous organic nature, which are usually formed from micro-biological growth and which attach themselves to other objects forming a coating.

Slip — (1) (Nautical) A docking place for a ship or boat between two piers; a *Slipway*. (2) The downslope movement of a soil mass

under wet or saturated conditions.

Slip-Off Slope Bank — The bank of a meandering stream which is not eroded by stream action, and which may be built up gradually.

Slipway — (Nautical) A sloping surface leading down to the water, on which ships are built or repaired and then more readily moved back into the water.

Slope — (1) The slope or inclination of a trench bottom or a trench side wall is the ratio of the vertical distance to the horizontal distance or “rise over run.” (2) The side of a hill or mountain, the inclined face of a cutting, canal or embankment or an inclination from the horizontal. In the United States, it is measured as the ratio of the number of units of horizontal distance to the number of corresponding units of vertical distance. The term is expressed as a percent when the slope is gentle, in which case the term *Gradient* is also used.

Slope Component — A morphological element of an erosional slope and a morphological subdivision of the sideslope landform element.

Slope-Discharge (Diagram) — A curve which shows the discharge at a given *Gaging Station*, taking into account the slope of the water surface, as well as the *Gage Height*. This curve may be plotted either by using the difference between elevations of water surface at two fixed gages on the stream, instead of the slope or by using the three variables of discharge, elevation of water surface at the lower gage, and elevation of the water surface at the upper gage.

Slope Protection — The protection of a *Slope* against wave action or erosion.

Slope Wash — Soil and rock material that is being or has been moved down a slope predominantly by the action of gravity assisted by running water that is not concentrated into channels. The term applies to the process as well as the materials.

Sloping Gage — A staff gage used to register the elevation of the water surface in a stream channel, conduit, reservoir or tank, with a scale graduated to represent vertical elevation. A sloping gage is usually installed on a flat sloping bank where it is desirable to increase the accuracy of reading the gage.

Slosh — (1) To spill or splash (a liquid) copiously or clumsily. (2) To agitate in a liquid.

Slough — (1) A general term for a marsh, swamp, or bayou, or for a sluggish body of water in such an area. (2) A place of deep mud or mire; a wet or marshy place as a swamp or marshland creek. Also a side channel or inlet as from a river; ordinarily found on or at the edge of the flood plain or a river; a *Bayou*. (3) (Localized) In the Mississippi Valley and in California, a tide flat or bottom-land creek. (4) (Sewage Disposal) Of a filter, to cast off a thin film of scum or a mass of bacterial growth or fungus. (5) Also *Slue*. A stagnant swamp, marsh, bog, or pond, especially as part of a bayou, and inlet, or a backwater. (6) (Geology) Any soft, muddy, or waterlogged ground or mudhole.

Sloughing (or Sloughing Off) — Movement of a mass of soil down a bank into the channel (also called *Slumping*). Sloughing is similar to a landslide.

Slow Sand Filter — Essentially, a concrete basin covered with graded gravel and about 3 feet of sand used to pass raw water through at low velocity, resulting in substantial removal of chemical and biological contaminants. Cleaning is accomplished by removing the surface layers of sand at periodic intervals. These are then washed and stored for reuse. The slow sand filtration process is simple, reliable and relatively inexpensive. The slow sand filter is an appropriate technique for removing suspended organic and inorganic matter and also may remove pathogenic organisms. The filter reduces bacteria, cloudiness, and organic levels, thereby reducing the need for disinfection and, consequently, the presence of disinfection byproducts in the finished water. There are limitations, however. Slow sand filters require a large land area, large quantities of filter media, and manual labor for cleaning. Water with high turbidity levels can quickly clog the fine sand used in these filters. Also, slow sand filters are less effective at removing microorganisms from cold water because as temperatures decrease, the biological activity within the filter bed declines. In operation, a sticky mat of biological matter, called a *Schmutzdecke*, forms on the sand surface, where particles are trapped and organic matter is biologically degraded. Slow sand filters rely on this cake filtration at the surface of the filter for particulate straining. As the surface cake develops during the filtration cycle, the cake assumes the dominant role in filtration rather than the granular media.

Slow Sand Filtration — A process involving passage of raw water through a bed of sand at low velocity (generally less than 0.4 meters per hour) resulting in substantial particulate removal by physical and biological mechanisms.

Sludge — (1) Mud, mire, or ooze covering the ground or forming a deposit, as on a riverbed. (2) Finely broken or half-formed ice on a body of water, especially the sea. (3) A thin surface layer of ice crystals separated from each other or only slightly frozen together, more solid than lolly ice but not yet a coherent ice rind. Also referred to as *Slush*, *Grease Ice*, or *Cream Ice*. (4) A mixture of cuttings and water formed at the bottom of a borehole after drilling. (5) (Geology) A soft, soupy or muddy stream-bottom deposit, especially a black ooze formed on the bottom of a lake. (Wastewater Treatment) (6) The concentrated solid material which has been collected in treatment plants. Sludge must be treated and disposed of with minimum pollution of air, land or water. Also, the settleable solids separated from water during processing. (7) A combination of solids and liquids resulting from sewage-treatment processes without thickening or physical or chemical pretreatment. Any undesirable solids settled out from a water or wastewater treatment process. (8) Semisolid material such as the type precipitated by a *Sewage Treatment Plant*. The terms *Biosolids*, *sludge*, and *Sewage Sludge* can be used interchangeably.

Sludge Age — A measure of the time biological solids are retained in a basin calculated by dividing the mass of volatile solids in the basin by the total mass of volatile solids wasted during a given time period. Expressed in units of time.

Sludge Bulking — A common problem encountered in the operation of activated sludge plants in which a portion of the sludge does not settle properly and is carried out with the effluent.

Sludge Deposits — Accumulations of settled, usually rapidly decomposing organic material in the aquatic system.

Sludge Digester — A tank in which complex organic substances like sewage sludges are biologically dredged. During these reactions, energy is released and much of the sewage is converted to methane, carbon dioxide, and water.

Sludge Digestion — The biological decomposition of solids collected during the operation of a facility designed to remove organic wastes from domestic or industrial sources. The total volume of solids is reduced by the *Mineralization* activity of bacteria, and the sludge remaining is rendered less reactive because the easily degraded compounds have been removed.

Sludge Disposal — The removal and discarding of thick watery suspensions of particulate waste matter. Final disposal may involve the removal of excess water and the subsequent burning of the solids, or placing the dewatered material in a landfill.

Sludge Volume Index (SVI) — (Wastewater Treatment) (1) A calculation which indicates the tendency of activated sludge solids (aerated solids) to thicken or to become concentrated during the sedimentation/thickening process. SVI is calculated in the following manner: (a) allow a mixed liquor sample from the aeration basin to settle for 30 minutes; (b) determine the suspended solids concentration for a sample of the same mixed liquor; (c) calculate SVI by dividing the measured (or observed) wet volume (mL/L) of the settled sludge by the dry weight concentration of MLSS in grams/L. (2) A laboratory test result used to indicate the rate at which *Sludge* is to be returned from the discharge end of an *Aeration Tank* to the inflow (upstream) end. It is calculated as:

$$\text{SVI} = (\text{SV/MLSS}) \times 1,000$$

with the result in milligrams/gram and where SV is the sludge volume (solids settled in a 1-liter graduated cylinder after 30 minutes, in milliliters/liter) and MLSS is the level of *Mixed Liquor Suspended Solids (MLSS)*, in milligrams/liter. The SVI has units of milliliters/gram. Used in conjunction with the *Activated Sludge Process*. Also known as the *Mohlman Index*.

Slue — See *Slough*.

Sluice — (1a) An artificial channel for conducting water, with a valve or gate to regulate the flow; (1b) A valve or gate used in such a channel; a *Floodgate* or *Sluice Gate*. (2) A body of water impounded behind a floodgate. (3) A *Sluiceway*. (4) A long inclined trough, as for carrying logs or separating gold ore.

Sluice Gate — A gate which can be raised or lowered by sliding in vertical guides.

Sluiceway — (1) An artificial channel, especially one for carrying off excess water. (2) An opening at a low level from a reservoir generally used for emptying or for scouring sediment and sometimes for irrigation releases. In such instances it is also referred to as a *Bottom Outlet* or *Low Level Outlet*.

Slump (Slumping) — (1) The sliding or gravitational movement of an overlying layer of soil, typically from becoming saturated, and lying on a rock layer or other relatively impermeable layer. (2) The downward slipping of a mass of rock or unconsolidated material, moving as a unit or as several subsidiary units, usually with backward rotation; or the material that has slid downslope.

Slurry — (1) A mixture of a solid suspended in a liquid, the solid usually in sufficient quantity to produce a thick or viscous mixture. (2) A watery mixture or suspension of insoluble (not dissolved) matter; a thin watery mud or any substance resembling it (such as a grit slurry or a lime slurry). (3) A thin, watery muck, or any substance resembling it, such as a lime slurry. The mixture is pourable and can be transported by pipe. (4) A very wet, highly mobile, semiviscous mixture or suspension of finely divided, insoluble matter, especially a muddy lake-bottom deposit having the consistency of a thick soup. (5) A mixture of cement and water pumped into a borehole or oil well to support the casing and prevent movement of underground fluids. (6) The form in which some raw material is added to an industrial process. Compare with *Liquor*.

Slurry Wall — (1) Material placed vertically in the ground to prevent the lateral movement of groundwater. (2) Barriers used to contain the flow of contaminated water or a subsurface liquid. Slurry walls are constructed by digging a trench around a contaminated area and filling it with an impermeable material that prevents water from passing through it. The groundwater or contaminated liquids can then be exacted or treated within the area confined by the slurry wall.

Slush — (1) Partially melted snow or ice. (2) Soft mud; slop; mire.

Slush Avalanche — See *Wet-Snow Avalanche*.

Small Stream Flooding — Nuisance flooding of very small creeks and streams due to excessive rainfall over small drainage areas. Should not be confused with flash flooding. Usually 0.5–1.0 inch (1.3–2.5 cm) of rainfall in an hour is sufficient to cause some small stream flooding.

SMCLs — See *Secondary Maximum Contaminant Levels (SMCLs)*.

Smoker — An extremely violent rapid in a river system. Also referred to as a *Hair*.

Snaking Stream — See *Meandering Stream*.

SNARL — Suggested No Adverse Response Level. The concentration of a chemical in water that is expected not to cause an adverse health effect.

SNOTEL — See *Snowpack Telemetry*.

Snow — (1) One of the common solid forms of precipitation (2) Precipitation in the form of branched, hexagonal crystals, often mixed with simple ice crystals, which fall more or less continuously from a solid cloud sheet. These crystals may fall either separately or in cohesive clusters forming *Snowflakes*.

Snow Ablation — The removal of snow by the force of the wind.

Snow, Cold Content of — The amount of heat required to raise the temperature of the snowpack to 0EC (32EF). Usually expressed as the number of inches of liquid water (produced at the surface by either rain or melt) which, on refreezing within the pack, will warm the snowpack to 0EC (32EF).

Snow Course — A line laid out and permanently marked on a drainage area along which the snow is sampled at definite distances or stations. Sampling occurs at appropriate times to determine snow depth, water equivalent, and density.

Snow Crystal — A configuration of ice crystals, usually in the shape of a hexagonal plane or delicate column, formed around a nucleus by sublimation, condensation and freezing, coalescence, or a combination thereof.

Snow Density — The ratio of the volume of meltwater derived from a sample of snow and the initial volume of the sample. This

is numerically equal to the specific gravity of the snow.

Snow Depth — The vertical distance between the surface of a snow layer and the ground beneath.

Snow Fence — A fence of slat and wire or other material used in winter to intercept drifting snow, thus protecting roads, railways, and other areas from snowdrifts. Also, fences used to impound snow where melting in place will add to the soil moisture content.

Snow Field — An area, usually at high elevation or in polar latitudes, where snow accumulates and remains on the ground throughout the entire year.

Snow Grains — Precipitation in the form of very small, white opaque particles of ice; the solid equivalent of drizzle. They resemble snow pellets in appearance, but are more flattened and elongated and generally have diameters less than 0.04 inch (1 mm). They neither bounce nor shatter upon impact with a hard surface.

Snow Line — (1) The general altitude to which the continuous snow cover of high mountains retreats in summer, such as the *Snowcap* of a mountain, chiefly controlled by the depth of the winter snowfall and by the summer temperature. (2) A line, sometimes drawn on a map during the winter, which shows the lower elevation of the snow cover at a particular time. (3) The fluctuating latitudinal boundaries around the polar regions marking the extent of snow cover.

Snow Line, Temporary — A line sometimes drawn on a weather map during the winter showing the southern limit of the snow cover.

Snow, Liquid Water Deficiency of — The difference between the liquid water-holding capacity and the water content of a snowpack.

Snow, Liquid Water-Holding Capacity of — The maximum amount of liquid water that a snowpack can hold against gravity at a given stage of metamorphism and density. When the liquid water-holding capacity is reached, the snowpack is said to be “ripe”.

Snow Making — The production of artificial snow in the form of granular ice particles for use on ski slopes.

Snow Management — The management of snow in such a way as to increase moisture for crop production. This is generally accomplished through the use of wind barriers, including grass and grass stubble barriers, but may also include trees and shrubs.

Snow Metamorphism — The transformation of snowflakes within a snowpack into different forms or structures.

Snow Niche — See *Nivation Hollow*.

Snow-Patch Erosion — See *Nivation*.

Snow Pellets — (1) A small white ice particle that falls as precipitation and breaks apart easily when it lands on a surface. (2) Precipitation consisting of white, opaque, near round or conical ice particles having a snow-like structure, and about 0.08 to 0.20 inch (2 to 5 mm) in diameter. Snow pellets are crisp and easily crushed, differing in this respect from snow grains. They rebound when they fall on a hard surface and often break up. Snow pellets form as a result of accretion of supercooled liquid water droplets collecting on an ice crystal. Also referred to as *Graupel* or *Soft Hail*.

Snow Quality — The ratio of the weight of the ice within a snowpack to the total weight of the snowpack, usually expressed as a percentage.

Snow Sample — A core taken from the snow mantle on a snow course from which the depth and density of snow may be determined.

Snow Sampler — An instrument used in obtaining snow samples, which consists of a set of light, jointed metal tubes for taking samples and a spring scale graduated to read directly the corresponding depth of water contained in the sample.

Snow Stake — A graduated fixed pole or staff used to measure snow depth.

Snow Survey — The process or operation of determining the depth, water content, and density of snow at various selected points on a drainage basin. This is done in order to determine the amount of water stored there in the form of snow for the purpose of forecasting subsequent runoff.

Snow, Thermal Quality of — The ratio of the amount of heat required to produce a specific quantity of water from a snowpack to the amount of heat required to produce the same quantity of water from pure ice at 0EC (32EF).

Snow, Water Equivalent of — The amount of water that would be obtained if the snowpack were melted, usually expressed in inches of water.

Snowbank Glacier — See *Nivation Glacier*.

Snowbelt — The northern parts of the United States that are subject to considerable snowfall.

Snowbound — Shut in by snow, as unable to leave.

Snowcap — Snow covering a mountain peak, especially such snow existing year-round.

Snowdrift — A mass or bank of snow piled up by the wind.

Snowfall — The amount of snow, hail, sleet, or other precipitation in solid form which reaches the earth's surface. It may be expressed in depth in inches as it falls, or in terms of depth in inches of the equivalent amount of water.

Snowflake — Precipitation which is made up of a number of snow crystals fused together.

Snowhedge — A planting of shrubs or other plants to intercept drifting snow. Also referred to as *Snowbreak* and *Snow Catch*.

Snowmelt — (1) The runoff from melting snow. (2) The net decrease in water equivalent of the snowpack after allowing for increases due to precipitation. It does not include water which refreezes or is retained as liquid water within the *Snowpack*. (3) A period or season when such runoff occurs.

Snowmelt Rate — The rate of conversion of ice into water within a snowpack.

Snowmold — (1) A disease of grasses appearing as grayish-white or pinkish patches after heavy snow has melted and caused by fungi that thrive at low temperatures. (2) A fungus that causes this disease.

Snowpack — A field of naturally packed snow that ordinarily melts slowly during the early summer months.

Snowpack Telemetry (SNOTEL) [NRCS] — A remote, automated measurement system operated and maintained by the U.S. Department of Agriculture, *Natural Resources Conservation Service (NRCS)* in the western United States to assess snowpack accumulation and potential streamflows. The concept is based upon the relationship between the water content in the snowpack

and spring runoff under certain assumptions. Forecasts of runoff are made through the coordination of hydrologists with the NRCS and the *National Weather Service (NWS)*. A typical SNOTEL site consists of: (1) a precipitation measurement tube which measures the actual level of precipitation in inches of equivalent water; (2) a snow “pillow” which measures the weight of the snowpack and therefore its water content, and (3) the measurement and transmitting equipment which send the data to NRCS collection offices.

Snowshed — A structure as over an extent of a railroad track for the protection against snowfall and snowdrifts.

Snowslide — An avalanche of snow.

Snowstorm — A storm accompanied by a heavy *Snowfall*.

Snowy — Abounding in or covered in snow.

Soak — (1) To make thoroughly wet or saturated by or as if by placing in liquid; to immerse in liquid for a period of time. (2) To absorb a liquid through or as if through pores or interstices.

Soakage — (1) The process of soaking; the condition of being soaked. (2) The amount of liquid that soaks into, through, or out of an object.

Soaker Hose — A low-flow watering device with small holes throughout the surface of the hose used to soak plant beds and gardens.

Society for Ecological Restoration (SER) — Founded in 1988, the Society for Ecological Restoration is an international, non-profit organization infused with the skills, experience, and dedication of some 2,300 members, consisting of individuals and organizations who are actively engaged in ecologically-sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge sets and cultural perspectives. SER promotes ecological restoration around the globe through a newsletter, a website, training programs, committees, working groups, two journals, and annual conferences. The policies of the SER are as follows:

- [1] **Protection of Ecosystems** – protection of ecosystems that are pristine or that otherwise exhibit characteristic diversity and functional attributes;
- [2] **Restitution** – will not sanction the destruction of any ecosystem on the pretext that it may be restored;
- [3] **Adoption of Ecological Restoration** – restoration is increasingly becoming an integral element in resource management and should be adopted generally as an essential practice by public agencies, non-governmental organizations, institutions, corporations, individuals, or other entities that own, control, or manage resources;
- [4] **Ecosystem Management** – advocates the ecologically sensitive management of ecosystems and landscapes, including restored ecosystems;
- [5] **Landscape Integration** – advocates the integration of restoration projects into regional landscapes, so as to maximize the effectiveness of restoration efforts;
- [6] **Culture and Sustainability** – recognizes that ecosystems, including restored ecosystems, are inseparable from human culture and economy;
- [7] **Biodiversity and Endangered Species** – advocates programs for preserving biodiversity and endangered species;
- [8] **Strategic Environmental Values of Restoration** – recognizes that the restoration and management of historical ecosystems contribute towards the solution of strategic environmental needs; and
- [9] **Global Reforestation Projects** – approves in principle of those projects by organizations and governments that contribute to global reforestation.

Socioeconomics — The study of the economic, demographic, and social interactions of humans.

SOCs — See *Synthetic Organic Chemicals (SOCs)*.

Soda Ash — (Water Quality) Also known as *Sodium Carbonate*, typically of chemical symbol Na_2CO_3 , a salt of strong alkaline taste used in making glass, soap, paper, chemical reagents and to remove non-carbonate hardness from water.

Soda Lake — A salt lake containing a high concentration of dissolved sodium salts, especially sodium carbonate together with sodium chloride and sodium sulfate. Also referred to as *Alkali Lake* and *Natron Lake*.

Sodic (Soils) — Soils having an excess concentration of sodium ions. Excess sodium results in poor aeration, slow infiltration rates, and causes serious nutritional disturbances in plants by affecting the availability of calcium, magnesium, and other ions required by plants.

Sodicity (of Soils) — A measure of the excess sodium in a soil which imparts a poor physical condition to the soil. *Sodic Soils* are generally impermeable to water, which makes it difficult to germinate crops.

Sodium Adsorption Ratio (SAR) — An expression of relative activity of sodium ions in exchange reactions with soil, indicating the sodium or alkali hazard to soil. It is calculated from the expression:

$$\text{SAR} = (\text{Na})/[(\text{Ca} + \text{Mg})/2]^{1/2}$$

where all quantities are expressed in milliequivalents per liter (meg/L). It is a particularly important measure in waters used for irrigation purposes. Waters range in respect to sodium hazard from those which can be used for irrigation on almost all soils to those which are generally unsatisfactory for irrigation.

Sodium Bicarbonate — (Wastewater Treatment) A white crystalline salt, NaHCO_3 , less soluble than *Sodium Carbonate* and having only a slight alkaline taste. Used as a *Coagulant Aid* in the neutralization process of wastewater treatment plants, it promotes more rapid settling, increases the efficiency of the coagulation process and extends the pH range to a level at which *Alum* (aluminum sulfate), a common inorganic coagulant, is effective.

Sodium Carbonate — (Water Quality) Any carbonate of sodium, typically Na_2CO_3 , a salt of strong alkaline taste, found in nature, as in soda lakes, but more often made artificially and used extensively in making glass, soap, paper, chemical reagents and in

the softening of water. Also referred to as *Soda Ash*.

Sodium Hypochlorite — (Water Quality) A water solution of sodium hydroxide and chlorine, NaOCl, used as a primary disinfectant in water treatment.

Soft Detergents — Cleaning agents that break down in nature.

Soft Hail — See *Snow Pellet*.

Soft Water — (1) Water that contains low concentrations of metal ions such as calcium and magnesium. This type of water does not precipitate soaps and detergents. (2) Water having a low concentration of calcium and magnesium ions. According to U.S. Geological Survey guidelines, soft water is water having a hardness of 60 milligrams per liter or less. Compare to *Hard Water*.

Softening — The removal of metal ions such as calcium and magnesium from water supplies. The converting of *Hard Water* to *Soft Water*.

Soil — Generally, the unconsolidated material above the bedrock that forms as a result of weathering by organic and inorganic processes. The meaning of this term varies depending on the field of consideration: (1) *Pedology* – the earth materials which have been so modified and acted upon by physical, chemical, and biological agents that it will support rooted plants; (2) *Engineering Geology* – the layer of incoherent rock material that nearly everywhere forms the surface of the land and rests on *Bedrock*, also called *Regolith*; (3) *Ecology* – A dynamic natural body on the surface of the earth in which plants grow, composed of mineral and organic materials and living forms.

Soil Absorption Field — A sub-surface area containing a trench or bed with clean stones and a system of piping through which treated sewage may seep into the surrounding soil for further treatment and disposal.

Soil Absorption System, Drip or Trickle — A shallow slow rate pressure-dosed system used for land application of treated wastewater, particularly under soil conditions unsuitable for normal septic tanks and gravity-fed soil absorption systems. In agriculture, drip soil irrigation systems irrigate crops by means of a network of shallow underground pipes fed by a pump. Such a system conserves water used in crop irrigation by applying it at a controlled rate in the root zone, minimizing evaporation and percolation losses. In the drip soil absorption system, the filtered effluent is delivered via supply lines to a subsurface drip field consisting of parallel rows of polyethylene tubing, known as dripper lines. Emitters are installed along these tubes to uniformly distribute and control the flow of effluent. The key to the effective operation of drip soil absorption systems is the slow and controlled rate at which it applies effluent over a large surface area, allowing relatively shallow placement of the dripper lines and long-term use without risk of saturating soils. This allows such systems to be effectively used for subsurface irrigation of trees, shrubs, and gardens in arid regions. Also see *Soil Absorption System, Septic Tank*.

Soil Absorption System, Septic Tank — A conventional wastewater treatment process used in isolated, rural, and other areas where normal sewer systems are not available whereby effluent is treated in a *Septic Tank*, then fed to soil-based disposal fields or trenches by gravity or under pressure. The quality of the ensuing filtration and absorption treatment is directly linked to soil and site characteristics such as permeability, drainage, slope, and depth to limiting conditions such as groundwater or bedrock. Unfortunately, many soils are classified as unsuitable for conventional soil absorption systems. Under such unsuitable soil conditions, alternative pretreatment systems may be employed to include sand filters, mound systems, evapotranspiration systems, low pressure pipe systems and a more complex drip soil absorption system. Also see *Soil Absorption System, Drip or Trickle*.

Soil Aggregates — Conglomeration of inorganic and organic matter in the *A-Horizon* which, if present, is referred to as the “mull” layer.

Soil Air — Below-ground air in the pore spaces between soil particles. Decomposition of organic matter in the soil can cause high concentrations of carbon dioxide in the soil air. The carbon dioxide combines with water to form carbonic acid, thereby increasing the acidity of the groundwater.

Soil Amendment — (1) Any material added to soil that enhances plant growth. (2) Organic matter added to soil to improve texture, aeration, drainage, and moisture retention.

Soil and Sediment Adsorption Isotherm Test — A test method that measures the *Adsorption* of a chemical substance to soil or sediment and thus indicates the likely distribution pathways in the environment. If a substance is readily adsorbed, it will increase in concentration in a soil or sediment layer; if it is not adsorbed, it will be free to move through the soil into groundwater or run off into surface water.

Soil and Sediment Erosion (Geoindicator) [GCRIO] — Soil erosion is an important social and economic problem and an essential factor in assessing ecosystem health and function. Estimates of erosion are essential to issues of land and water management, including sediment transport and storage in lowlands, reservoirs, estuaries, and irrigation and hydropower systems. In the United States, soil has recently been eroded at about 17 times the rate at which it forms. Specifically, about 90 percent of U.S. cropland is currently losing soil above the sustainable rate. Soil erosion rates in Asia, Africa and South America are estimated to be about twice as high as in the United States. Erosion, the detachment of particles of soil and surficial sediments and rocks, occurs by hydrological (fluvial) processes of sheet erosion, rilling and gully erosion, and through mass wasting and the action of wind. Erosion, both fluvial and eolian (wind) is generally greatest in arid and semi-arid regions, where soil is poorly developed and vegetation provides relatively little protection. Where land use causes soil disturbance, erosion may increase greatly above natural rates. In uplands, the rate of soil and sediment erosion approaches that of denudation (the lowering of the Earth's surface by erosional processes). In many areas, however, the storage of eroded sediment on hillslopes of lower inclination, in bottomlands, and in lakes and reservoirs, leads to rates of stream sediment transport much lower than the rate of denudation. When runoff occurs, less water enters the ground, thus reducing crop productivity. Soil erosion also reduces the levels of the basic plant nutrients needed for crops, trees and other plants, and decreases the diversity and abundance of soil organisms. Stream sediment degrades water supplies for municipal and industrial use, and provides an important transporting medium for a wide range of chemical pollutants that are readily sorbed on sediment surfaces. Increased turbidity of coastal waters due to sediment load may adversely affect organisms such as benthic algae, corals, and fish. See *Geoindicators [U.S. Global Change Research*

Information Office].

Soil and Water Conservation Practices — Control measures consisting of managerial, vegetative, and structural practices to reduce the loss of soil and water.

Soil Bioengineering — A process involving the use of live and dead woody cuttings and poles or posts collected from native plants to revegetate watershed slopes and stream banks. The cuttings, posts, and vegetative systems composed of bundles, layers, and mats of the cuttings and posts provide structure, drains, and vegetative cover to repair eroding and slumping slopes. Also referred to as *Biotechnical Slope Protection*.

Soil Classification — The systematic arrangement of soils into groups or categories on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties. *Soil Taxonomy* is the study of soil classification systems. For a description of soil classifications, see *Land Capability Classes*.

Soil Conditioner — An organic material like humus or compost that helps soil absorb water, build a bacterial community, and take up mineral nutrients.

Soil Conservation — (1) The use of land, within the limits of economic practicability, according to its capabilities and its needs to keep it permanently productive. (2) Any of various methods to achieve the maximum utilization of the land and preservation of its resources and quality, through such controls as crop rotation, prevention of soil erosion, etc.

Soil Conservation District (SCD) — Soil Conservation District (also called Soil and Water Conservation District, SWCD, in some areas); a local government entity with in a defined water or soil protection area that provides assistance to farmers and other local residents in conserving natural resources, especially soil and water.

(United States) Soil Conservation Service (SCS) — Former name of the *U.S. Natural Resources Conservation Service (NRCS)*, an agency of the U.S. Department of Agriculture (USDA).

Soil Core — A sample of soil taken by forcing a cylindrical device into the ground perpendicular to the horizontal. The resulting sample contains a circular section of each layer of sediment.

Soil Creep — The slow mass movement of soil materials down slopes primarily under the influence of gravity, but facilitated by saturation with water and/or by alternating freezing and thawing.

Soil Erodibility — An indicator or measure of a soil's susceptibility to raindrop impact, runoff, and other erosive processes.

Soil Erosion — The detachment and movement of soil from the land surface by wind or water.

Soil Flushing — A treatment technique for cleaning soil contaminated with inorganic or organic hazardous waste. The process involves the flooding of the soil with a flushing solution, which may be acidic, basic, or contain *Surfactants*, and the subsequent removal of the *Leachate* via shallow wells or subsurface drains. The recovered leachate is then purified.

Soil Horizon — A layer of soil approximately parallel to the surface, which differs from adjacent layers in chemical and physical properties.

Soil Management — The basis of all scientific agriculture, which involves six essential practices: (1) proper tillage; (2) maintenance of a proper supply of organic matter in the soil; (3) maintenance of a proper nutrient supply, including water; (4) control of soil pollution; (5) maintenance of the correct soil acidity; and (6) control of erosion.

Soil Moisture (Soil Water) — Water diffused in the upper part of the *Unsaturated Zone (Zone of Aeration)* of the soil, from which water is discharged by the *Transpiration* of plants, by *Evaporation*, or *Interflow*. Also referred to as *Soil Moisture Content* or *Available Water Content (AWC)*.

Soil-Moisture Depletion — The process where soil water is removed by crops through *Evapotranspiration*.

Soil-Moisture Deficiency (or Deficit) — The difference between the water-holding capacity of the soil and the instantaneous soil moisture.

Soil Moisture Regime — The changes in the moisture content of soil during a year.

Soil-Moisture Retention — That part of the soil moisture retained by surface tension and molecular forces against the influence of gravity.

Soil-Moisture Sensor — A device attached to an automatic irrigation or sprinkler system that monitors the level of drops or water administered to the soil based on the level of *Soil Moisture*.

Soil Monolith — A vertical section of a soil profile removed and mounted for display or study.

Soil Morphology — The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile and by the texture, structure, consistency, and porosity of each horizon.

Soil Productivity — The capacity of a soil, in its normal environment, to produce a specific plant or sequence of plants under a specific system of management.

Soil Profile — (1) The arrangement of soil horizons or layers below the ground surface. (2) A vertical section of the soil from the surface through all its layers or horizons. The three basic horizontal layers that may be observed in a soil profile are the A, B, and C horizons. The A horizon, or topsoil, is the main source of plant nutrients. Soluble materials leach from the A horizon down to the subsoil, or B horizon. This is the zone of clay accumulation. The deepest layer, the C horizon, is composed of partially weathered bedrock. Also referred to as *Soil Horizons*. Also see *Soil Core*.

Soil Quality (Geoindicator) [GCRIO] — As one of Earth's most vital ecosystems, soil is essential for the continued existence of life on the planet. As sources, stores, and transformers of plant nutrients, soils have a major influence on terrestrial ecosystems. Soils continuously recycle plant and animal remains, and they are major support systems for human life, determining the agricultural production capacity of the land. Soils buffer and filter pollutants, they store moisture and nutrients, and they are important sources and sinks for CO₂, methane and nitrous oxides. Soils are a key system for the hydrological cycle. Soils also provide an archive of past climatic conditions and human influences. Soils vary greatly in time and space. Over time-scales relevant to *Geoindicators*, they have both stable characteristics (e.g. mineralogical composition and relative proportions of sand,

silt and clay) and those that respond rapidly to changing environmental conditions (e.g. ground freezing). The latter characteristics include soil moisture and soil microbiota (e.g. nematodes, microbes), which are essential to fluxes of plant nutrients and greenhouse gases. The soils of boreal regions are estimated to hold the equivalent of some 60 percent of the current atmospheric carbon: long-term warming is expected to increase decomposition and drying, thus potentially releasing huge volumes of methane and CO₂. Recent research shows that the Alaskan tundra no longer serves as a carbon sink, but has begun to release significant quantities of carbon. Most soils resist short-term climate change, but some may undergo irreversible change such as lateritic hardening and densification, podsolization, or large-scale erosion. Soil properties and climatic variables such as mean annual rainfall and temperature can be related by mathematical functions known as climofunctions. Chemical degradation takes place because of depletion of soluble elements through rainwater leaching, overcropping and overgrazing, or because of the accumulation of salts precipitated from rising groundwater or irrigation schemes. It may also be caused by sewage containing toxic metals, precipitation of acidic and other airborne contaminants, as well as by persistent use of fertilizers and pesticides. A widespread problem is the retention in the soil organic matter and clay minerals of potentially toxic metals and radionuclides (e.g., Copper – Cu, Mercury – Hg, Lead – Pb, Zinc – Zn, Radium – ²²⁶Ra, Uranium – ²³⁸U). These and other chemical components may be catastrophically released as what are commonly referred to as “chemical time bombs” where the pH of the soil is decreased by acidification or where other environmental disturbances (e.g. erosion, drought, land use change) intervene. Soils also act as a primary barrier against the migration of organic contaminants into groundwater. Key indicators are pH, organic matter content, sodium absorption ratio, cation exchange capacity, and cation saturation. Physical degradation results from land clearing, erosion and compaction by machinery. Soil structure may be altered so that infiltration capacity and porosity are decreased, and bulk density and resistance to root penetration are increased. Such soils have impeded drainage and are quickly saturated: the resultant runoff can cause accelerated erosion and transport of pollutants such as pesticides. The key soil indicators are texture (especially clay content), bulk density, aggregate stability and size distribution, and water-holding capacity.

Soil Sorption Coefficient (K_d) — A parameter relating the partitioning of a chemical between soil and water in a soil-water mixture. The coefficient is computed by:

$$K_d = C_s / C_w$$

where C_s is the amount of a specific chemical bonded to the soil (micrograms chemical per gram of soil) and C_w is the concentration of the same substance dissolved in the water (micrograms of the chemical per gram of water).

Soil Structure — (1) The physical properties of different soils. (2) The arrangement of soil particles into aggregates. Sand has little structure because sand particles do not tend to stick together, whereas clay has a firm structure because clay particles tend to pack tightly together to form a solid material.

Soil Taxonomy — The systematic study and arrangement of soils into classifications based on their characteristics. For a description of soil classifications, see *Land Capability Classification*.

Soil Texture — (1) A classification of soils based on the size distribution of mineral grains comprising the soil. (2) The relative proportions of silt, sand, clay, and gravel in a soil.

Soil Thin-Layer Chromatography — A method used to estimate the potential for leaching a chemical from soil by measuring the mobility of the chemical in soil under controlled conditions.

Soil Tilth — Refers to the ease with which a soil can be worked. A soil with good tilth is well aerated and can be easily penetrated by roots. It is easy to break, crumble or crush.

Soil Toxicity — A measure of the toxic effects that a soil and its constituents may have on plants and/or animals. A number of elements have varied effects on plant growth as well as aquatic habitat and downstream drinking water supplies. Some of the more common toxic substances include excess levels of boron, arsenic, molybdenum, selenium, nitrate, and mercury. Other elements of growing concern include Nickel, Uranium, Copper, Manganese, Lead, Calcium, Zinc, Silver, Chromium, Beryllium, Lithium, and Cobalt.

Soil Vapor Survey — A non-invasive method for the detection of volatile or semivolatile organic contaminants in shallow subsurface soil. The technology is especially useful in the analysis of soils with a high sand content and of shallow groundwater. A probe is driven into the ground, and samples of vapors in the soil are drawn to the surface for analysis.

Soil Water — Water present in the soil pores. Also referred to as *Soil Moisture* which includes *Water Vapor*.

Soil Water Tension — The work that must be done per unit quantity of pure water to transport it from free water at the same elevation to soil water. Also referred to as *Matric* or *Capillary Potential*.

Soil Zone — The *Root Zone*.

(Water-Related) Soils — (Geology) The following represent a number of water-related soil types:

- [1] **Aqualf** — A suborder of the soil order *Alfisol* that develops in water-saturated areas and is characterized by a gray or mottled color.
- [2] **Aquent** — A suborder of the soil order *Entisol* that develops in areas periodically saturated with water and is characterized by a bluish-gray or greenish-gray color.
- [3] **Aquept** — A suborder of the soil order *Inceptisol* that develops in areas where restricted natural drainage results in water saturation; characterized by a dark surface horizon over a mottled or gray subsoil.
- [4] **Aquod** — A suborder of the soil order *Spodosol* that develops in water-saturated areas as a result of fluctuating water tables or humid climates; characterized by a black surface horizon, a white albic horizon, or a cemented spodic horizon.
- [5] **Aquoll** — A suborder of the soil order *Mollisol* that develops in areas periodically saturated with water; characterized

by a black surface horizon over a mottled or gray subsoil.

- [6] **Aquox** — A suborder of the soil order *Oxisol* that develops in areas periodically saturated with water and is characterized by a mottled subsoil.
- [7] **Aquult** — A suborder of the soil order *Ultisol* that develops in areas periodically saturated with water and is characterized by a gray or mottled color.

Solar Aquatic Systems (SAS) — A technology which, under controlled conditions, duplicates the natural water purification processes of streams and wetlands. The solar greenhouse wastewater treatment system includes solar tanks which optimize photosynthetic reactions and biological activity, and artificially-controlled ponds and wetlands which replicate a natural environment. Within such a system, wastewater is circulated through ecologically-engineered aquatic environments where the contaminants and nutrients are metabolized or “bound up.” Typically, tertiary treatment of wastewater requires up to four days.

Solar Lake — A lake that has no connection to the sea and whose water temperature and salinity increase with depth.

Solar Pond — A pool of salt water heated by the sun and used either as a direct source of heat or to provide power for an electric generator.

Solder — A metallic compound used to seal joints between pipes. Until recently, most solder contained 50 percent lead. Use of lead solder containing more than 0.2 percent lead in pipes carrying drinking water is now prohibited.

Sole Source Aquifer (SSA) — An aquifer that is the sole or principal source (50 percent or more) of drinking water for a geographical area, as established under Section 1424(e) of the *Safe Drinking Water Act (SDWA)*. This designation bars the use of federal funds for projects in the *Recharge Zone* that may lead to a significant hazard to the public health by degrading groundwater quality in the aquifer. Also see *Critical Aquifer Protection Area (CAPA)*.

Solid — A state of matter, neither liquid nor gas. The solid state of water is ice.

Solid Waste — (1) All items discarded after use in a solid state that must be collected and disposed of separately. Solid waste is collected by municipal collection systems. Solid waste does not include items discarded into sewage systems or those emitted with smoke or gas. (2) Any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous materials resulting from industrial, municipal, commercial, mining, and agricultural operations, and from community and institutional activities.

Solifluction — (1) The slow downhill flow or creep of soil and other loose materials that have become saturated. (2) The slow (normally 0.5-5.0 cm/year), viscous, downslope flow of water logged soil and other unsorted and saturated surficial material.

Solubility — (1) The relative capacity of a substance to serve as a solute. Sugar has a high solubility in water, whereas gold has a low solubility in water. (2) (Chemistry) The ability or tendency of one substance to dissolve into another at a given temperature and pressure; generally expressed in terms of the amount of solute that will dissolve in a given amount of solvent to produce a saturated solution.

Solubilize — To make (substances such as fats and lipids) soluble in water by the action of a detergent or similar agent.

Soluble — That which can be dissolved; able to pass into solution.

Soluble Minerals — Naturally occurring substances capable of being dissolved.

Soluble Reactive Phosphate (SRP) — That phosphate which is detected by analysis of a sample which has been filtered through a 0.45 μm (10^{-6} meter) membrane filter.

Solum — The top two soil layers, composed of the topsoil (*A-Horizon*) and the subsoil (*B-Horizon*, or layer of leached material deposition). The solum excludes the parent material layer (*C-Horizon*). Also referred to as the *Zone of Eluviation*. Also see *Soil Profile*.

Solute — (1) Any material which is dissolved in another, such as salt dissolved in water. (2) Any substance that is dissolved in water.

Solute Transport — The movement of dissolved substances through a *Hydrogeologic Unit*.

Solute Transport Model — Mathematical model used to predict the movement of solutes (generally contaminants) in an aquifer through time.

Solution — (1) A homogeneous mixture of a solute in a solvent. (2) A liquid mixture of dissolved substances. In a solution it is impossible to see all the separate parts. For example, when sugar (the solute) is dissolved in water (the solvent), the molecules that comprise the sugar crystal are separated from one another and dispersed throughout the liquid medium.

Solution Channel — Tubular or planar channel formed by solution in carbonate-rock terrains, usually along joints and bedding planes.

Solution Mining — The removal of a mineral deposit that is soluble in water. Water is injected into the geological strata containing the mineral and the dissolved material is recovered by wells. The method is applied to mine salt (sodium chloride) and potash (potassium chloride), among others.

Solvent — Any material which acts to dissolve another, such as water dissolving salt. The solvent constitutes the dissolving medium, or liquid portion, of a solution. Water is frequently referred to as the universal solvent. The term also applies to organic materials (e.g., benzene, acetone, or gasoline) used to clean (dissolve) oils or grease from machinery, fabrics, or other surfaces, or to extract hydrocarbons from some source material.

Solvent Recovery — A method to minimize hazardous waste by recovering process solvents for reuse. Common techniques are distillation or absorption of the solvent from a solvent-containing mixture.

Sonar — A system using transmitted and reflected underwater sound waves to detect and locate submerged objects or measure the distance to the floor of a body of water.

Sop — (1) To dip, soak, or drench in a liquid; saturate. (2) To take up by absorption.

Sorption — (1) A surface phenomenon which may be either absorption or adsorption, or a combination of the two; often used when the specific mechanism is not known. (2) Processes that remove solutes from the fluid phase and concentrate them on the solid

phase of a medium; used to encompass absorption and adsorption.

Sorption Water — See *Pellicular Water*.

Sound (Water) — (1) A long, relatively wide body of water, larger than a strait or a channel, connecting larger bodies of water and between the mainland and one or more islands. (2) A long, wide ocean inlet. (3) To measure the depth of water, especially by means of a weighted line; *Fathom*.

Sounding — (1) Measuring the depth of water, as in a well, river, or lake; *Fathom*. (2) A probe of the environment for scientific observation. (3) A place or part of a body of water where a hand sounding line will reach bottom.

Sounding Line — (Nautical) A line marked at intervals of fathoms and weighted at one end, used to determine the depth of water. Also referred to as a *Lead Line*.

Sounding Tube — A pipe or tube used for measuring the depths of water.

Sour — Of or relating to excessively acid soil that is damaging to crops.

Source Control [EPA] — Source control refers to a range of actions (e.g., removal, treatment in place, and containment) designed to protect human health and the environment by eliminating or minimizing migration of or exposure to significant contamination.

Source Materials [EPA] — Material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir (either stationary or mobile) for migration of contamination to groundwater, to surface water, to air (or other environmental media)], or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material although non-aqueous phase liquids (occurring as residual or free-phase) may be viewed as source materials.

Source Water Assessment Program (SWAP) [EPA] — A requirement established under 1996 amendments to the *Safe Drinking Water Act (SDWA)* which requires every state with primacy for the Public Water Supply Supervision program to develop and implement a program intended to identify ground and surface waters that supply drinking water for public water systems. Once a source area is identified or delineated, a state must then locate contaminants within the delineated area which could potentially degrade source water.

Source Water Protection — The prevention of pollution of the lakes, reservoirs, rivers, streams, and groundwater that serve as sources of drinking water. Wellhead protection would be an example of a source water protection approach that protects groundwater sources, whereas management of land around a lake or reservoir used for drinking water would be an example for surface water supplies. Source water protection programs typically include: delineating source water protection areas; identifying sources of contamination; implementing measures to manage these changes; and planning for the future.

Source Water Protection Program (SWPP) [EPA] — A program encouraged and highly recommended under 1996 amendments to the *Safe Drinking Water Act (SDWA)* intended to develop and implement a program to extend and supplement existing *Wellhead Protection Programs (WPP)* by allowing communities and local governments to obtain financial assistance to protect both surface and ground public drinking water sources from future contamination.

Souse — (1) To plunge into a liquid. (2) To make soaking wet; drench.

Souse Hole — In a river system, a hole found below an underwater obstruction, such as a boulder. This term usually refers to holes of narrow or moderate width that have water pouring not only from the upstream and downstream directions but also from the sides.

Southern Nevada Water Authority (SNWA) [Nevada] — An agency created in 1991 through a cooperative agreement among the seven regional water and wastewater agencies in southern Nevada. The purpose of the SNWA was to address water resource management and water conservation on a regional basis through *Integrated Resource Planning (IRP)* techniques and, through such efforts, plan, manage, and develop additional supplies of water for southern Nevada. The seven regional agencies comprising the SNWA include:

- [1] Big Bend Water District (Laughlin)
- [2] City of Boulder City
- [3] City of Henderson
- [4] City of Las Vegas
- [5] City of North Las Vegas (serving portions of unincorporated Clark County and the City of Las Vegas)
- [6] Clark County Sanitation District
- [7] Las Vegas Valley Water District (LVVWD, serving the City of Las Vegas and portions of unincorporated Clark County)

Potable water in the Las Vegas region is provided by five different water purveyors: Big Bend Water District, Boulder City, City of Henderson, Las Vegas Valley Water District (LVVWD), and the City of North Las Vegas. Wastewater service is provided by four different agencies: Boulder City, City of Henderson, the City of Las Vegas and Clark County Sanitation District. Also see *Southern Nevada Water System (SNWS)*.

Southern Nevada Water System (SNWS) [Nevada] — On October 22, 1965, President Lyndon B. Johnson signed legislation authorizing construction of the Alfred Merritt Smith Water Treatment Facility and the Robert B. Griffith Water Project. These two projects form the Southern Nevada Water System, which supplies municipal and industrial water to the Las Vegas Valley Water District, Nellis Air Force Base and the cities of Boulder City, Henderson, and North Las Vegas. The Southern Nevada Water System refers to the system of treatment and transmission facilities that diverts raw Colorado River water from Lake Mead, and delivers potable water to three major retail water purveyors in the Las Vegas Valley, as well as Nellis Air Force Base and Boulder City. The treatment facility, located on the shores of Lake Mead, is known as the Alfred Merritt Smith Water Treatment Facility (AMSWTF). The transmission facilities, which divert water from Lake Mead to the treatment plant and then deliver treated water to Boulder City through the River Mountains tunnel and throughout the Las Vegas Valley, are referred to as the Robert B. Griffith Water Project. Treatment facilities were constructed in two stages by the State of Nevada acting through its

Colorado River Commission. Transmission facilities were also constructed in two stages by the federal government through the *U.S. Bureau of Reclamation (BLM)*. The state and federal facilities work together to form the Southern Nevada Water System which, as of January 1, 1996, is controlled by the *Southern Nevada Water Authority (SNWA)*. SNWA in turn employs the Las Vegas Valley Water District (LVVWD) as its operating agent.

Treatment Facilities – Treatment facilities currently have the capacity to treat 600 million gallons per day (MGD). Until completion of the SNWS Phase II Improvements in 1999, delivery capability is 480 MGD. During 1997 the treatment plant produced an average of 314.8 MGD. The maximum day production was 469.5 MGD. The treatment process involves disinfection, aeration, flocculation, filtration and post-treatment. Disinfection is accomplished primarily by the application of chlorine; however, new facilities will employ ozonation for disinfection as well. Aeration is done primarily to improve aesthetic qualities of the water. Flocculation is a chemical process that causes minute particles in the water to coagulate into larger particles that can be filtered out. Filtration is provided by 26 filters, each with 2800 square feet of surface area; the filter media is composed of anthracite coal, silica sand, and aggregate. Filter performance is monitored and, when it declines below acceptable limits, the filter is backwashed. All backwash water is reclaimed and recycled to the head of the facility; no backwash water is returned to Lake Mead. Sludge captured in the backwash process is dried and disposed of in a landfill. Post-treatment is the addition of a small amount of chemicals to retard corrosion, and additional chlorine if necessary, to prevent bacteriological regrowth in the distribution systems. Water quality is assured by testing samples taken from over 260 different locations throughout the system. Samples are tested for chemical, microbiological, and other contaminants. Lake Mead has proven to be a very high quality water source which, along with effective design and operation of the treatment facilities, allows SNWS to provide water that exceeds all applicable standards to the over one million people in the Las Vegas Valley.

Transmission Facilities – Transmission facilities begin with the 13-foot diameter intake tunnel, which diverts Lake Mead water from 150 feet below its surface and conveys it through Saddle Island to Pumping Plant #1. The pumping plant lifts the water up to the raw water aqueduct, which conveys it to the AMSWTF. Treated water is lifted 708 feet to the River Mountains Tunnel, where it flows 4 miles by gravity to the Las Vegas Valley. After emerging from the tunnel, water is diverted to various points throughout the valley, where it is handed off to the facilities of retail purveyors at 17 rate-of-flow control stations. Pumping plants are used to move the water uphill, and rate-of-flow control stations are used to regulate and measure the flow into customers' storage facilities. Water from the AMSWTF is also conveyed to Boulder City by five pumping plants and eight miles of pipelines. Once it enters the system, treated water is never exposed to open air until the consumer uses it. SNWS consumes approximately 10 percent of the power generated by Nevada Power Company, making it the largest single customer.

Major Components of the Transmission Facilities – (1) Intake Tunnel: 1400 feet long, 13 feet in diameter; (2) 6 miles of raw and treated water aqueducts, 10 feet in diameter, and associated surge tanks; (3) River Mountains Tunnel: 4 miles long, 12 feet in diameter; (4) 14 major pumping plants and associated electrical equipment; (5) 18 major lateral systems totaling over 80 miles of pipeline as large as 12 feet in diameter; (6) 17 rate-of-flow control stations and associated regulating tanks.

Spa — (1) A mineral spring regarded as having medicinal qualities. (2) A place having such a spring. (3) A resort providing therapeutic baths. (4) A resort area having mineral springs. (5) A tub for relaxation or invigoration, usually including a device for raising whirlpools in the water.

Sparkling Water — Water charged with carbon dioxide (CO₂).

Spate — (1) A sudden flood, rush, or outpouring. (2) (Chiefly British) A *Flash Flood*; a *Freshet* resulting from a downpour of rain or melting snow; a sudden heavy fall of rain.

Spatter — (1) To scatter in drops or small blobs. (2) A mark or wet spot caused by spattering.

Spawning — The depositing and fertilizing of eggs (or roe) by fish and other aquatic life.

SPCC — Spill Prevention Control and Countermeasure.

Special Assessment District — A legally established area for the express purpose of levying a special fee for public improvements that are of a special rather than a general benefit.

Special District — A political subdivision of a state established to provide a single public service (as water supply or sanitation) within a specific geographical area. Also see *General Improvement District (GID)*.

Special Flood Hazard Area (SFHA) — (1) Areas in a community that have been identified as susceptible to a one-percent or greater chance of flooding in any given year. A one-percent-probability flood is also known as the 100-year flood or the base flood. (2) An area having special flood, mudslide, or flood-related erosion hazards, and shown on a *Flood Boundary Floodway Map (FBFM)*, *Floodway Hazard Boundary Map (FHBM)*, or a *Flood Insurance Rate Map (FIRM)*. SFHA's are further subdivided into *Flood Hazard Zones A, AO, AH, A1-A30, AE, A99, AR, AR/A, AR/AE, AR/A1-A30, AR/AH, AR/AO, V, V1-V30, and VE*.

Species — (Biology and Botany) (1) A group of individuals having a common origin and a continuous breeding system. A basic category of biological classification intended to designate a single kind of animal or plant. (2) A class having some common characteristics or qualities. The major subdivision of a genus or subgenus, regarded as the basic category of biological classification, composed of related individuals that resemble one another, are able to breed among themselves but are not able to breed with members of another species.

Species Diversity — (1) The number of different *Species* occurring in some location or under some condition. (2) (Biodiversity Measure) Shannon-Weiner diversity index based on richness and evenness of species. It is the most commonly used measure of biological diversity, and the Shannon-Weiner diversity index is the most widely used metric for this measure.

Species of Special Concern [California] — Species which are not federal or state-listed as endangered, threatened, or rare, but are declining or are so few in number in California that extirpation is a possibility.

Species Richness by Rarity Class — (Biodiversity Measure) The proportion of rare species or communities present (based on known or likely presence within the basin) by rarity class (i.e., rare: occur only in some watersheds; uncommon: >1 in most watersheds; common: many representatives in all or most watersheds). This measure provides information on the distribution of abundances across species which, when compared with historical accounts, offers an index of the trend of biological diversity in the area at the species/population scale of the biological dimension.

Specific Capacity (of a Well) — (1) Well yield in gallons per minute per foot of drawdown. (2) In groundwater hydrology, the ratio of the discharge or yield of a well, usually measured in gallons per minute per foot, to drawdown after a period of sustained pumping.

Specific Conductance — (1) A rapid method of estimating the dissolved-solids content of a water supply. The measurement indicates the capacity of a sample of water to carry an electrical current, which is related to the concentration of ionized substances in the water. Also called *Conductance*. (2) A measure of the ability of water to conduct an electrical current as measured using a 1 cm cell and expressed in units of electrical conductance, i.e., siemens or microsiemens (μS or μmho) at 25°C. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the total dissolved solids (TDS) content of water by testing its capacity to carry an electrical current. Commonly, the concentration of dissolved solids (in milligrams per liter, mg/L) is from 55 to 75 percent of the specific conductances (in microsiemens, μS). This relation is not constant from stream to stream, and it may vary in the same source with changes in the composition of the water. For comparison, the specific conductance of sea water is approximately 50,000 μS , which is equivalent to a TDS concentration of about 35,000 milligrams per liter (mg/l). (Water Quality) Specific conductance is used in groundwater monitoring as an indication of the presence of ions of chemical substances that may have been released by a leaking landfill or other waste storage or disposal facility. A higher specific conductance in water drawn from *Downgradient Wells* when compared to *Upgradient Wells* indicates possible contamination from the facility.

Specific Discharge (Specific Flux) — For groundwater, the rate of discharge per unit area, measured at right angles to the direction of flow.

Specific Drawdown — The drawdown in a well per unit discharge.

Specific Energy — (1) The energy of water at any cross section of a stream, equal to the sum of the water depth and the velocity head at that cross section. (2) The sum of the *Piezometric Head* and the velocity head; total energy, with respect to the bottom of a conduit or channel as a datum.

Specific Gravity (SG or SP GR) — (1) Weight of a particle, substance, or chemical solution in relation to the weight of water. Water has a specific gravity of 1.000 at 4 degrees C (39 degrees F). Particulates in raw water may have a specific gravity of 1.005 to 2.5. (2) The ratio of the density of a substance to the density of some substance (as pure water) taken as a standard when both densities are obtained by weighing in air. (3) The ratio of the mass of a solid or liquid to the mass of an equal volume of distilled water at 4°C (39°F) or of a gas to an equal volume of air or hydrogen under prescribed conditions of temperature and pressure. Relative to water, the specific gravity (SG) is given by:

$$\text{SG} = \rho / \rho_w$$

where ρ is the density (weight per unit volume) of the unknown substance and ρ_w is the density of water. The parameter has no units and is frequently used to determine the concentration of a *Solution*.

Specific Heat (SP HT) — (1) The ratio of the amount of heat required to raise the temperature of a unit mass of a substance by one unit of temperature to the amount of heat required to raise the temperature of a similar mass of a reference material, usually water, by the same amount. (2) The amount of heat, measured in calories, required to raise the temperature of one gram of a substance by one Celsius degree (1°C); the specific heat of water is 1 calorie.

Specific Humidity — (Meteorology) (1) The mass of water vapor per unit mass of moist air. (2) In any system of moist air, the ratio of the mass of water vapor to the total mass of the system.

Specific Retention (of a Water-Table Aquifer) — (1) Generally, a measure of the water-retaining capacity of a porous medium. (2) The ratio of the volume of water that a given body of rock or soil will hold against the pull of gravity to the volume of the body itself. It is usually expressed as a percentage. (3) The amount of water held in saturated rock or soil after the excess gravitational water has drained away as compared to the total volume of the rock or soil. Specific retention is dependent on both pore characteristics as well as factors affecting the surface tension, such as temperature, viscosity, mineral composition of the water, etc. Also referred to as *Field Capacity* or *Water-Holding Capacity*. Also see *Porosity* and *Effective Porosity*.

Specific Storage — The volume of water removed or added within the unit volume of an aquifer per unit change in head.

Specific Yield — (1) A measure of water available to wells, equal to the percentage by volume of gravity water that will drain from a given mass of saturated rock or soil. (2) The quantity of water that a unit volume of saturated permeable rock or soil will yield when drained by gravity. Specific yield may be expressed as a ratio or as a percentage by volume.

Specific Yield (of an Aquifer) — The volume of water available per unit volume of aquifer, if drawn by gravity. Specific yield is expressed as a percent. For example, if 0.2 cubic meter of water will drain from 1 cubic meter of aquifer sand, the specific yield is 20 percent.

Specific Yield (Groundwater) — The ratio of the volume of water that a rock will yield by gravity, after being saturated, to its own volume, expressed as a percentage.

Specification — The process in the construction of *Econometric Models* during the selection of the *Independent* or *Exogenous Variables* by which we attempt to provide the best and most complete explanation of the *Dependent* or *Endogenous Variable*.

Correct model specification results in a representation of the “true” physical, economic, or behavioral relationships described by the model’s structure. Mis-specified models generally result from the inclusion of irrelevant variables in the model’s structure or relevant variables omitted from the model. Another model mis-specification can occur when the model is represented by a linear relationship when in fact the true relationship is nonlinear, or vice versa.

Spectroscopic Hygrometer — An instrument used to measure the selective absorption by water vapor of light in certain bands of the spectrum.

Sphagnum Bog — (Ecology) An area of moist soil, rich in organic debris from acid-tolerant mosses.

Spiles — (Irrigation) Small pipes, generally straight, from 1–4 inches (2.5–10 centimeters) in diameter, used to distribute water from a ditch into furrows, borders, or corrugations.

Spill — (1) To cause or allow to run or fall from a container unintentionally so as to be lost or wasted. (2) With respect to a dam and reservoir system, the water passed over a spillway without going through turbines to produce electricity. Spill can be forced, when there is no storage capability and flows exceed turbine capacity, or planned, for example, when water is spilled to enhance fish passage or to support other downstream uses (e.g., agriculture, wetland maintenance, etc.). (3) With reference to reservoir operations, water that is released, either inadvertently or through precautionary releases, in excess of that required to compensate for deliver system losses and to meet irrigation demand.

Spill Prevention Control and Countermeasures Plan (SPCCP) — A plan covering the release of hazardous substances as defined in the *Clean Water Act (CWA)*.

Spill Stream — See *Overflow Stream*.

Spillway — (1) An open or closed channel, conduit, or drop structure used to convey water from a reservoir. Release overflow for water impounded by a dam. (2) The channel or passageway around or over a dam through which excess water is diverted. If the flow is controlled by gates, it is a controlled spillway; if the elevation of the spillway crest is the only control, it is an uncontrolled spillway. The following lists some typical spillways:

- [1] **Auxiliary Spillway (Emergency Spillway)** – A secondary spillway designed to operate only during exceptionally large floods;
- [2] **Fuse Plug Spillway** – An auxiliary or emergency spillway comprising a low embankment or a natural saddle designed to be overtopped and eroded away during normal inflow and flood flows;
- [3] **Primary Spillway (Principal Spillway)** – The principal or first-used spillway during normal inflow and flood flows;
- [4] **Shaft Spillway (Morning Glory Spillway)** – A vertical or inclined shaft into which flood water spills and then is conducted through, under, or around a dam by means of a conduit or tunnel; if the upper part of the shaft is splayed out and terminates in a circular horizontal weir, it is termed a “bellmouth” or “morning glory” spillway;
- [5] **Side Channel Spillway** – A spillway whose crest is roughly parallel to the channel immediately downstream of the spillway;
- [6] **Siphon Spillway** – A spillway with one or more siphons built at crest level; this type of spillway is sometimes used for providing automatic surface-level regulation within narrow limits or when considerable discharge capacity is necessary within a short period of time.

Spillway Design Flood — The flood that the spillway of a given project is designated to pass safely without overtopping the structure.

Spit — (1) A narrow point of land extending into a body of water. (2) A brief, scattered fall of rain or snow.

Spits — Depositional formations caused by the lateral movement of water along a shoreline known as *Littoral Drift*. Wave energy rarely, if ever, makes perfectly perpendicular contact with the shoreline. Instead, the waves hit the shoreline at an angle, causing a lateral movement of water and sediment in whichever direction the waves are angled toward. This lateral movement results in the deposition of sediment along the coastline where wave energy goes from high to low. For the most part, spits are thought of as coastal marine formations, but they are also very evident in many large lakes that exist today. Barrier spits form due to wave action known as littoral drift which deposits sediments at a low energy area.

Splash — (1) To cause (a liquid substance) to scatter and fall in drops or blobs. (2) To dash or scatter a liquid substance, mud, etc. on, so as to wet or soil.

Splash Zone — (Ecology) See *Supralittoral Zone*.

Splashboard — (Nautical) A screen on a boat to keep water from splashing onto the deck. (2) A board for closing a *Spillway* or *Sluice*.

Splashdown — A spacecraft’s soft landing on the water, thereby permitting recovery of personnel and critical components.

Splat — A splattering or wet, slapping sound.

Splatter — To *Spat* or *Splash*.

Splays — In valley sediment deposition, splays consist of local accumulations of bed load materials which are spread from channels on to adjacent floodplains. See *Valley Sediment Deposits*.

Split Stream — A stream that divides into two channels as it passes around an island or other such obstruction.

Spoil — (1) Excavated material such as soil from the trench of a water main. (2) Soil or rock material excavated from a canal, ditch, basin, or similar construction. (3) Debris or waste from a coal mine or other mining activity.

Spoil Bank — The accumulation of overburden or non-ore material removed in gaining access to the ore or mineral material in surface mining.

Spongy — (1) Porous; absorbent. (2) Soft and thoroughly soaked with moisture.

Sponson — A light air-filled structure or a winglike part protruding from the hull of a seaplane to steady it on water.

Spore — The reproductive body of an organism which is capable of giving rise to a new organism either directly or indirectly. A

viable (able to live and grow) body regarded as the resting stage of an organism. A spore is usually more resistant to disinfectants and heat than most organisms.

Spout — To gush forth in a rapid stream or in spurts.

Spray — (1) A cloud or mist of fine liquid particles, as of water from breaking waves. (2) A jet of fine liquid particles, or mist, as from an atomizer or spray gun.

Spray Chamber — A device that removes certain organic compounds from an airstream by condensation. A cooling material, usually water, is sprayed into a chamber, and the condensed organics exit with the water. In addition to the removal of the condensable contaminants, the condensation greatly reduces the volume of the waste exhaust. Also referred to as a *Contact Condenser*.

Spray Field (also Sprayfield) — (1) Refers to the release of reclaimed water or treated effluent on the surface of the ground through a variety of sprinkler heads or nozzles (including overhead systems, center pivot systems, periodic moving systems, and portable or traveling gun systems). Also see *Land Application*. (2) (Wastewater) Sprayfields are a threat to the environment and are directly related to wastewater *Lagoons* and “factory farms.” Manure is periodically pumped out of lagoons and sprayed on fields. Although manure can be an excellent fertilizer when it is applied at rates that crops can absorb, it must be safely, and sensibly applied. But factory farms produce far more manure than their land requires, and they often over-apply it to fields, causing it to run off the fields and into rivers and streams, constituting a major source of *Non-Point Source* pollution (NPS). Farmers may also spray when it is rainy or windy, or with little regard for adjacent property. In addition, the act of spraying wastes increases evaporation and vaporization of pollutants.

Spray Irrigation — Any irrigation by means of nozzles along a pipe or from perforated overhead pipes.

Spray Tower — (Air Quality) An air pollution control device in which contaminated air is passed through a tower containing substances (packing) possessing large surface area. Water is passed over the packing material in a countercurrent fashion, i.e., in a direction opposite to the passage of the air, and the air contaminants are then absorbed into the liquid. Also referred to as *Absorption Tower*, *Packed Tower*, or *Tray Tower*.

Spray Tower Scrubber — A device that sprays alkaline water into a chamber where acid gases are present to aid in the neutralizing of the gas.

Spread/Spreading — A method of recharging a *Groundwater Basin* by diverting water to a highly-pervious area for *Percolation* into the basin. Also see *Recharge*, *Artificial*.

Spreading Basin — A surface facility, often a large pond, used to increase the percolation of surface water into a *Groundwater Basin*. Also referred to as *Recharge Basin*.

Spreading Grounds — The same as a *Spreading Basin*.

Spring (Water) — (1) Groundwater seeping out of the earth where the water table intersects the ground surface. (2) A concentrated discharge of groundwater coming out at the surface as flowing water; a place where the water table crops out at the surface of the ground and where water flows out more or less continuously. (3) A place where groundwater flows naturally from a rock or the soil into the land surface or into a body of surface water. Its occurrence depends on the nature and relationship of rocks, especially permeable and impermeable strata, on the position of the water table, and on the topography.

Spring, Cold — A spring whose water has a temperature appreciably below the mean annual atmospheric temperature in the area.

Spring, Hot — A thermal spring whose temperature is above that of the human body.

Spring Line — (1) A line of springs marking the point at which the water table intersects with the land surface. (2) The theoretical center of a pipeline.

Spring Melt/Thaw — The process whereby warm temperatures melt winter snow and ice. Because various forms of acid deposition may have been stored in the frozen water, the melt can result in abnormally large amounts of acidity entering streams and rivers, sometimes causing fish kills.

Spring Overturn — (1) (Ecology) The mixing of the waters in a lake due to the melting of ice and snow, resulting in uniform water temperatures at every level of the lake. (2) A physical phenomenon that may take place in a lake or similar body of water during the early spring, most frequently in lakes located in temperate zones where the winter temperatures are low enough to result in freezing of the lake surface. The sequence of events leading to spring overturn include: (a) the melting of ice cover; (b) the warming of surface waters; (c) density changes in surface waters producing convection currents from top to bottom; (d) circulation of the total water volume by wind action; and (e) vertical temperature equality. The overturn results in a uniformity of the physical and chemical properties of the entire water mass. Also see *Fall Overturn*. Also referred to as *Spring Turnover*.

Spring Runoff — Snow melting in the spring causes water bodies to rise. This in streams and rivers is called “spring runoff”.

Spring Tide — The highest high and the lowest low tides during the lunar month. The exceptionally high and low tides that occur at the time of the new moon or the full moon when the sun, moon, and earth are approximately aligned. Contrast with *Neap Tide*.

Sprinkle — A light rainfall.

Sprinkler Irrigation — A pressurized irrigation system where water is distributed through pipes to the field and applied through a variety of sprinkler heads or nozzles. Pressure is used to spread water droplets above the crop canopy to simulate rainfall. These systems include portable and traveling guns, solid or permanent fixtures (overhead or pop ups), center pivots, and periodic moving systems. The efficiencies of these sprinkler systems range from 15 to 85 percent; however, the average of 70 percent is commonly used. Also referred to as *Overhead Irrigation*.

Spritz — To squirt or spray (something like water) quickly.

Spume — (1) Foam or froth on a liquid, as on the sea. (2) To froth or foam.

Squall — A brief, sudden, violent windstorm, often accompanied by rain or snow.

SSA — See *Sole Source Aquifer (SSA)*.

SSAD — *Sole Source Aquifer Demonstration*.

Stability — (Ecological) (1) The tendency of systems, especially ecosystems, to persist, relatively unchanged, through time. (2) A condition whereby system variables return to equilibrium after being disturbed. Stability within ecosystems results from various population feedback mechanisms and integration of disturbances at larger spatial scales.

Stability Hazard — A potential or rating for a slope assessing its susceptibility to slope failure.

Stabilization — (Environmental) A broad expression used to denote a process that is intended to lessen the damage that a pollutant or discharge causes in the environment; the process of changing an active substance into inert, harmless material, or physical activities at a site that act to limit the further spread of contamination without actual reduction of toxicity. For example, the stabilization of sewage involves allowing microorganisms to degrade those components that can be decomposed.

Stabilization [EPA] — Refers to “stabilizing” a situation such that, for example, the contamination does not represent unacceptable near-term threats or does not continue to spread. Stabilization used in this context does not refer to engineered treatment used to “solidify” wastes, although such technologies could be used as a stabilization action.

Stable Canal System — A canal system in which flow disturbances are attenuated.

Stable Isotope Ratio — A unit expressing the ratio of the abundance of two *Radioactive Isotopes*. Isotope ratios are used in hydrologic studies to determine the age or source of specific waters, to evaluate mixing of different waters, as an aid in determining reaction rates, and other chemical or hydrologic processes.

Staff Gage — A graduated scale used to indicate the height of the water surface in a stream channel, reservoir, lake, or other water body.

Stage — The height of a water surface above some established reference point or *Datum* (not the bottom) at a given location. Also referred to as *Gage Height*.

Stage-Capacity Curve — (1) A graph illustrating the relationship between river stage and volume of discharge. (2) A graph showing the relation of the surface elevation of the water in a reservoir, usually plotted as the ordinate (y-axis), to the volume below that elevation, plotted as the abscissa (x-axis). Also referred to as *Rating Curve* or *Discharge-Rating Curve*.

Stage-Discharge Curve (Rating Curve) — A graph showing the relation between the gage height, usually plotted as the ordinate, and the amount of water flowing in a channel, expressed as volume per unit of time and plotted as the abscissa.

Stage-Discharge Relationship — The relationship between the amount of water flowing in a river or stream and *Stage* at any particular point, usually represented by means of a *Rating Curve* or *Rating Table*.

Stage Marker — A gauge (*Gage*) placed along a river shoreline that is calibrated in feet or fractions thereof starting from an arbitrary zero point. With appropriate conversion information, these readings may be converted into *Cubic Feet per Second (CFS)* or, more important, “raftability” ratings. See *River Rating*.

Stagnant Basin — An isolated or barren basin containing motionless water, capable of supporting only *Anaerobic* life forms.

Stagnant Water — A body of water that is not flowing or otherwise moving.

Stagnation — (1) The condition of a body of water that is not flowing in a stream or is otherwise motionless, being unstirred by currents or waves. (2) A lack of motion in a mass of water that tends to hold pollutants in place. (3) The condition of a *Glacier* that has ceased to flow.

Stagnation Point — A place in a ground-water flow field at which the groundwater is not moving. The magnitude of vectors of *Hydraulic Head* at the point are equal but opposite in direction.

Stagnum — A small lake or pool having no outlet.

Staircase — A stretch of river where the water pours over a series of drops that resemble a staircase.

Stakeholder — (Planning) Anyone who has a vested interest in an issue. Individuals and organizations with an interest in a particular area, issue or project. Stakeholders may include public agencies at all levels (i.e., federal, state and local), non-profit organizations, private landowners, industry, and others.

Stakeholders [EPA] — A term used to collectively refer to state and EPA regulators, owners and operators of facilities subject to *Resource Conservation and Recovery Act (RCRA)* corrective action, members of tribal governments, and members of the public and affected communities. The “public” in the context of RCRA refers not only to private citizens, but also to the representatives of consumer, environmental, and minority associations; trade, industrial, agricultural, and labor organizations; public health, scientific, and professional societies; civic associations; public officials; and government and educational associations.

Stalactite — An icicle-shaped mineral deposit, usually calcite or aragonite, hanging from the roof of a cavern, formed from the dripping of mineral-rich water. Contrast with *Stalagmite*.

Stalagmite — A conical mineral deposit, usually calcite or aragonite, built up on the floor of a cavern, formed from the dripping of mineral-rich water. Contrast with *Stalactite*.

Stale Water — Water which has not flowed recently and may have picked up tastes and odors from distribution lines or storage facilities.

Stand — A biotic community, particularly of trees, possessing sufficient uniformity of composition, age, and spatial arrangement to be distinguishable from adjacent communities. Stand structure refers to the composition, age, and arrangement of the trees in a delimited biotic community.

Stand Density Index (SDI) — A relative measure of competition in a forest stand based on number of trees per unit area and average tree size.

Standard — (1) A physical or chemical quantity whose value is known exactly, and is used to calibrate or standardize instruments. Also see *Reference*. (2) A pre-mixed solution with a known amount of material to be tested; can be used for calibration of equipment, but also to check monitoring accuracy of tests and procedures.

Standard Deviation (σ) — (Statistics) A measure of the variability of a series of data about its mean value. The standard deviation is equal to the square root of the *Variance*, from which it is derived, and measures the sum of the differences between a series’

values and its mean. The standard deviation for a large data set (the population standard deviation) is calculated as:

$$\sigma = [\Sigma(x_i - \bar{x})^2/n]^{-2}$$

where:

x_i is an individual observation;

$\bar{x}$ is the mean of all observations; and

n is the number of observations.

For smaller data sets (typically less than 50) the sample standard deviation (s) is calculated by replacing n with $(n-1)$ in this equation.

Standard Industrial Classification (SIC) Codes — Industry codes developed by the U.S. Office of Management and Budget and published in the *SIC Manual* (1987 edition) defining industries according to the composition and structure of the entire economy. Each firm, based on its principal product or service, is assigned a 4-digit SIC code. The first two digits (range 01–99) indicate the major industrial category, and the last two digits classify the company further. For example, major category codes 20–39 identify manufacturing facilities; code 28 within this range is the major category code for chemical and allied products manufacturing, and the 4-digit SIC code 2869 is the classification for industrial organic chemicals, not elsewhere classified (N.E.C.). Environmental regulations are often applied to facilities within certain SIC codes based on pollution potential. Also, such industry coding is also applicable in assessing commercial water use by industry sector based upon either employment levels or output. This form of analysis is used in deriving industry water use based on GED (gallons per employee per day) water use coefficients. The following listing presents the 4-digit code ranges of the SIC coding by major industry classifications and industries covered.

SIC Code Range	Industries Covered
[0100 – 09XX]	Agriculture, Forestry, and Fishing
[1000 – 1499]	Mining
[1500 – 1799]	Construction
[2000 – 3999]	Manufacturing
[4100 – 4959]	Transportation, Communications, and Public Utilities
[5000 – 5999]	Wholesale and Retail Trade
[6000 – 6799]	Finance, Insurance, and Real Estate
[7000 – 8999]	Service Industries
[9100 – 93XX]	Government
[9400 – 97XX]	Administration of Education, Health, and Social Programs

Also see *Gallons per Employee per Day (GED)*.

Standard Methods — A short form for *Standard Methods for the Examination of Water and Wastewater* which is prepared and published every five years jointly by the *American Public Health Association*, *American Water Works Association*, and the *Water Environment Federation*. The book serves as the primary reference for analytical methods employed in investigations and monitoring of water purification, sewage treatment and disposal, water pollution, sanitary quality, and other functions.

Standard Methods for the Examination of Water and Wastewater — See *Standard Methods*.

Standard Permeability — The permeability corresponding to a temperature of 60°F.

Standard Project Flood — (1) The flood that may be expected from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. (2) (U.S. Army Corps of Engineers) A term used to designate a flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. The peak flow for a standard project flood is generally 40 to 60 percent of the probable maximum flood for the same location.

Standard Sample — (1) The part of finished drinking water that is examined for the presence of coliform bacteria. (2) The aliquot of finished drinking water that is examined for the presence of coliform bacteria.

Standard Solution — A solution in which the exact concentration of a chemical or compound is known.

Standardize — To compare with a standard. (1) In wet chemistry, to find out the exact strength of a solution by comparing it with a standard of known strength. (2) To set up an instrument or device to read a standard. This allows you to adjust the instrument so that it reads accurately, or enables you to apply a correction factor to the readings.

Standardized Precipitation Index (SPI) — A precipitation index based on the probability of precipitation for any time duration. The SPI was specifically designed to quantify the precipitation deficit for multiple periods of time reflecting the impact of drought on the availability of different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale, while groundwater, stream flow and reservoir storage levels reflect the longer-term precipitation anomalies. For this reason, the SPI is calculated on both a short-term and long-term (up to four years) basis. Positive SPI values indicate greater than median (middle-most) precipitation, while negative values indicate less than median precipitation. Because the index is normalized, wetter and drier climates can be determined in the same way. A drought event occurs any time the SPI is continuously negative

and reaches an intensity where the SPI is -1.0 or less. SPI indexes range as shown in the follow table:

SPI Measure	Drought Condition
2.0 or greater	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2.0 or less	Extremely dry

Also see *Drought Indexes (Indices)*.

Standards — Norms that impose limits on the amount of pollutants or emissions produced by an activity. The *U.S. Environmental Protection Agency (EPA)* establishes minimum standards, but individual states are allowed to be more strict.

Standing (Water) — Water that is not flowing, as stagnant.

Standing Crop — The quantity of plant *Biomass* in a given area. For example, the amount of plant material per acre of forest or swamp, or per cubic meter of water. Usually expressed as mass (dry) per unit area, or energy content per unit area.

Standing Water — Water that has no motion or current; *Stagnant Water*.

Standing Wave — A wave caused by the deceleration of current that occurs when fast-moving water slams into slower-moving water. Unlike ocean waves, which sweep forward while the water in them remains relatively still, merely rising and falling in place, these waves stand in a fixed position while the water washes through them. The height of these waves is measured vertically from the trough to the crest.

Standpipe — (1) A large vertical pipe into which water is pumped in order to produce a desired pressure; a high vertical pipe or reservoir that is used to secure a uniform pressure in a water-supply system. (2) A pipe or tank connected to a closed conduit and extending to or above the hydraulic grade line of the conduit to afford relief from surges of pressure in pipelines. (3) A tank used for storage of water in distribution systems.

Stank — (1) (British) Pond, pool. (2) A ditch containing water. (3) (British) A small dam or weir.

State — The agency of the State or Tribal government which has jurisdiction over public water systems. During any period when a State or Tribal government does not have primary enforcement responsibility pursuant to Section 1413 of the *Safe Drinking Water Act (SDWA)*, the term “State” means the Regional Administrator, *U.S. Environmental Protection Agency (EPA)*.

State Coordinating Agency — (FEMA) The agency of the state government designated by the Governor of the state at the request of the Administrator to coordinate the flood insurance program in that state.

State Engineer — The official most often charged with the administration of the water appropriation system within a state. In some states this function is assigned to a board or department.

State Water Project (SWP) [California] — A state-owned and operated water project consisting of twenty-two dams and reservoirs which deliver 2.4 million acre-feet of water (“firm yield”) each year from the Sacramento Valley to the San Francisco Bay Area, Central Valley and Los Angeles. Water in the upper Feather River is provided from the SWP for water supply and recreational uses, while Oroville Dam forms the project’s largest storage reservoir with a capacity of 3.5 million acre-feet. From Oroville Reservoir, water flows south to the Sacramento-San Joaquin Delta where the North and South Bay aqueducts serve communities in the southern San Francisco Bay area. The 444-mile long Edmund G. Brown California Aqueduct begins at the Delta Pumping Plant and follows Interstate 5 south to the Tehachapi Mountains where it is pumped vertically some 2,000 feet at the Robert D. Edmonston Pumping Plant into southern California. About 30 percent of SWP water is used for irrigation, primarily in the San Joaquin Valley, while about 70 percent of the water is used for residential, municipal and industrial use, mainly in southern California. The SWP and the federally-funded *Central Valley Project (CVP)* work in conjunction to serve a number of municipal and industrial and agricultural needs throughout California.

State Water Resources Control Board (SWRCB) [California] — The water rights and water permitting agency of the State of California. The SWRCB consists of five members (to include a Chairman and Vice Chairman) whose responsibility it is to “protect water quality and allocate water rights” within the State of California. To assist in these functions, the SWRCB is served by a staff to include an Executive Director, a Chief Deputy and nine (9) Regional Board Executive Officers serving the regions of:

- [1] North Coast Region;
- [2] San Francisco Bay Region;
- [3] Central Coast Region;
- [4] Los Angeles Region;
- [5] Central Valley Region;
- [6] Lahontan Region;
- [7] Colorado River Basin Region;
- [8] Santa Ana Region; and
- [9] San Diego Region.

State Wellhead Protection Program — A program established to protect wellhead protection areas within a State’s jurisdiction from

contaminants that may have any adverse effects on the health of persons (*Safe Drinking Water Act (SDWA)*, subsection 1428[a]). See *Wellhead Protection (Program)*.

Static (Fixed Water) — Pertaining to water stored in a tank but not under pressure.

Static Head — (1) The difference in elevation in feet between the water surface of the body of water being pumped and the centerline of the discharge pipe at the point of release. It is the lift measured in feet. (2) When water is not moving, the vertical distance (in feet) from a specific point to the water surface is the static head. (The static pressure in psi is the static head in feet times 0.433 psi/ft.) Also see *Dynamic Pressure* and *Static Pressure*.

Static Level — (1) The height or level to which water will rise in a well under its full pressure head. Also referred to as *Hydrostatic Level*. (2) The water level of a well that is not affected by the removal of *Groundwater*. (3) The elevation of a static liquid surface.

Static Level (Groundwater) — The level of water in a nonpumping or nonflowing well. For the purpose of computing the drawdown, it generally is the water level immediately before pumping begins.

Static Lift — The vertical distance between source and discharge water levels in a pump installation.

Static Oceanography — (Oceanography) The study of the non-dynamic aspects of oceanography, for example, the structure of the ocean floor and the physical and chemical composition of seawater.

Static Pressure — (1) The pressure exerted by a still liquid or gas, especially water or air. (2) When water is not moving, the vertical distance (in feet) from a specific point to the water surface is the static head. The static pressure in psi is the static head in feet times 0.433 psi/ft. Also see *Dynamic Pressure* and *Static Pressure*.

Static Water Depth — (Hydraulics) For a water well, the vertical distance from the centerline of the pump discharge down to the surface level of the free pool while no water is being drawn from the pool or water table.

Static Water Level — (1) The depth to water measured from the ground surface; shut-in pressure measured at the ground surface. (2) The elevation or level of the water table in a well when the pump is not operating. (3) The level or elevation to which water would rise in a tube connected to an *Artesian Aquifer* or basin in a conduit under pressure.

Statistical Inference — (Statistics) The area of statistics that describes the procedures by which we use the observed data (the sample) to draw conclusions about the population from which the data came or about the process by which the data were generated. Our assumptions is that there is an unknown process that generates the data and that this process can be described by a probability distribution, i.e., a likelihood of occurring. Statistical inference can be classified as *Classical Inference* and *Bayesian Inference*.

Statistical Tests of Significance — (Statistics) Mathematical methods of stating the probability that two data sets are not from the same *Population*; specifically, that there is an actual difference in some characteristic between the two groups. These tests are commonly used in instances in which one sample has been affected by some disturbance (cause and effect) and the other has not. Statistical tests are designed to determine if measured differences between the two sample groups are due to random sample variability or to cause-and-effect relationships.

Statistically Significant — (Statistics) Describes the difference between two groups or two samples from the same population, one of which serves as the unaffected control group and the other having been subject to manipulation (cause and effect) by some external factor. *Statistical Tests of Significance* can be applied to determine if the observed resultant differences are due to the cause-and-effect hypothesis or to random sampling variability.

Statistics — The mathematics of the collection, organization, and interpretation of numerical data by inference from sampling.

Statutory Adjudication — See *Adjudication*.

Statutory Law — A body of law based on statutes enacted by a legislature.

Steady Flow — Flow in which the rate remains constant with respect to time at a given cross-section.

Steady State — (1) State of balance in a *Hydrologic System* where little or no change in hydraulic head occurs through time. (2) In a system with a flow-through of material (e.g., water) or energy, the equilibrium condition in which the flow in equals the flow out.

Steady-State Conditions — Synonymous with *Equilibrium* conditions.

Steady-State or Apparent Plateau — (Biology) In testing chemical substances for their *Bioconcentration Potential* in fish, the situation in which the amount of chemical substance taken into the test fish from the water is equal to the amount being eliminated from the test fish. If the substance bioconcentrates in the fish, the steady-state condition will follow an uptake phase in which the absorbance rate exceeds the elimination rate.

Steam — The vapor that forms when water is heated to the boiling point. Steam under pressure is capable of driving a piston in a piston engine or turning the blade of a turbine.

Stream Depletion — See *Depletion*.

Steam, Dry — A steam that is so hot that no water droplets are present in it.

Steam Injection Well — A method of recovering deposits of oil and other minerals which involves injecting steam directly into the deposit to decrease viscosity and facilitate extraction. Also used in deep-buried oil-sand deposits in an “in situ” process to separate the bitumen from the sand so it may be pumped to the surface along with water and a trace of natural gas.

Steam Stripping — The removal of volatile compounds from wastewater by forcing steam through the liquid. The higher the wastewater temperature increases, the higher the evaporation rate of the volatile contaminants.

Stemflow — (1) The rainfall or snowmelt led to the ground down the trunks or stems of plants. (2) Water that reaches the ground by flowing down from tree trunks or plant stems.

Stenobathic — (Ecology) Limited to or able to live only within a narrow range of water depths. Used of aquatic organisms.

Stenohaline — (Ecology) Pertaining to an aquatic organism unable to withstand wide variation in salinity of the surrounding water.

Stenohydric — (Ecology) Describing an organism that is able to tolerate only a narrow range of moisture levels.

Stenohygic — (Ecology) Describing an organism that is able to tolerate only a narrow range of humidity levels.

Step Aeration — (Water Quality) A modification of the *Activated Sludge Process* wherein the waste enters the aeration tank at a number of different points, while recycled sludge enters at the head of the tank.

Step Feed Aeration — (Wastewater Treatment) Step feed aeration is a modification of the conventional activated sludge process. In step aeration, primary effluent enters the aeration tank at several points along the length of the tank, rather than all of the primary effluent entering at the beginning or head of the tank and flowing through the entire tank in a plug flow mode.

Step Lake — See *Pateroster Lake*.

Sterile (Water) — A condition in which a quantity of water does not contain viable organisms such as viruses and bacteria. The term, however, is not synonymous with clean.

Sterilization (of Water) — (1) The process of killing, inactivating, or removing microorganisms (bacteria, viruses, etc.) from a quantity of water. (2) The removal or destruction of all microorganisms, including pathogenic and other bacteria, vegetative forms and spores. Compare with *Disinfection*. The normal methods of sterilization involve agents such as heat, chemicals, or radiation.

Stewardship — (Ecology) (1) Caring for land and associated resources and maintaining healthy ecosystems for future generations. (2) Administrative and/or custodial actions taken to preserve and protect the *Natural Resources*, particularly the plant (*Flora*) and animal (*Fauna*) life, of an area or *Ecosystem*.

Still Water (or Stillwater) — (1) A nearly level reach of a stream having no visible current or other motion. (2) A stream whose water appears sluggish, showing little or no turbulence. (3) A flat or level section of a stream where no flow or motion of the current is discernible and the water is still.

Still-Water Level — (Oceanography) the level the ocean's surface would be if there were no wave or wind action: in deep water, approximately at the midpoint of wave height; in shallow water, nearer to the trough.

Stilling Basin — An open structure or excavation at the foot of an overfall, chute, drop, or *Spillway* to reduce the energy of the descending stream. A basin constructed to dissipate the energy of fast-flowing water, e.g., from a spillway or *Bottom Outlet*, and to protect the stream bed below a dam from erosion.

Stilling Well — (1) A device used to allow monitoring of water levels in turbulent flow. (2) A well or chamber which is connected to the main flow channel by a small inlet. Waves and surges in the main flow stream will not appear in the well due to the small diameter inlet. The liquid surface in the well will be quiet, but will follow all of the steady fluctuations of the open channel. The liquid level in the well is measured to determine the flow in the main channel.

Stillwater National Wildlife Refuge (NWR) [Nevada] — One of the nine National Wildlife Refuges (NWR) located in the State of Nevada, the Stillwater NWR is part of the *Stillwater Wildlife Management Area [Nevada]* and contained within the *Lahontan Valley Wetland System [Nevada]*, a key, resting, migration, and wintering area for up to 1 million waterfowl, shorebirds, and raptors. The Stillwater NWR is located approximately 15 miles east of Fallon, Nevada within Churchill County on the edge of the Carson Sink and was formally established in 1991 when 77,500 acres (121 square miles) of the Stillwater Wildlife Management Area were set aside to preserve critical nesting and habitat for migratory waterfowl and other birds using the Pacific Flyway in western Nevada. Each spring and fall, it hosts a significant percentage of the Pacific Flyway's migratory birds. The Lahontan Valley wetland system was named to the *Western Hemisphere Shorebird Reserve Network* in 1988, and it has been nominated for inclusion under the *Convention of Wetlands of International Importance*, attesting to the continental significance of this invaluable resource. By one estimate, in the early 1900s the Lahontan Valley wetland system alone contained about 85,000 acres of wetlands visited by millions of waterfowl and shorebirds using the eastern edge of the Pacific Flyway during migration. With the advent of the *Newlands (Irrigation) Project [Nevada]*, fresh water that traditionally charged the wetlands was replaced by a greatly diminished supply of agricultural drain water. The wetlands initially benefitted from the Newlands Project diversions of large quantities of Truckee River water, including winter hydro releases at Lahontan Dam on the Carson River, that provided the wetlands with considerable infusions of fresh water. As the federal government sought to protect Pyramid Lake's fisheries and the endangered cui-ui (*Chasmistes cujus*) and threatened Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) by reducing Truckee River diversions (at Derby Dam on the lower Truckee) and other actions to improve Newlands Project efficiency, the wetlands became increasingly dependent on agricultural drainwater as flows into the project were reduced. This drainwater has, at times, contributed to water quality problems and has generally not provided an adequate inflow into the wetlands. Overall, since the Newlands Project has been in operation, wetland acreage in the Lahontan Valley has declined by 85 percent. Because it is one of only three large interior basin wetland systems along the west coast, deterioration of Lahontan Valley wetlands has already markedly reduced the carrying capacity of the Pacific Flyway. On November 16, 1990, Congress passed *Public Law 101-618* (also referred to as the *Negotiated Settlement*) authorizing the purchase and transfer of enough water rights to maintain a total of 25,000 acres of primary wetlands in the Lahontan Valley (to include Stillwater National Wildlife Refuge: 14,000 acres; Carson Lake and Pasture: 10,200 acres; and Fallon Reservation and Indian Lakes: 800 acres). The Department of the Interior, *U.S. Fish and Wildlife Service (USFWS)* estimates this may require up to 125,000 acre-feet of water annually. Also see *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Stillwater Wildlife Management Area [Nevada] — An extensive and diverse wetland area located at the termination of the Carson River and on the edge of the Carson Sink situated approximately ten miles northeast of Fallon, Nevada in Churchill County. In the 1860s, Pony Express riders using this route reported great flights of birds darkening the skies. However, in the early 1900s, with the completion of the *Newlands Irrigation Project* and the diversion of much of the flows of the Carson River, this wetland area was reduced from deep-water ponds favored by waterfowl to dense jungles of tules and cattails. As the favored habitat all but disappeared, the bird populations dwindled to a remnant. The Stillwater Wildlife Management Area was established to preserve these critical nesting and habitat areas for migratory waterfowl and other birds using the Pacific Flyway in western Nevada. In 1948, in order to preserve a shrinking wetland system, the *U.S. Fish and Wildlife Service (USFWS)* and the Nevada

Fish and Game Commission entered into an agreement with the *Truckee–Carson Irrigation District (TCID)* to develop and manage 224,000 acres (350 square miles) of *U.S. Bureau of Reclamation (USBR)*–Newlands (Irrigation) Project lands, which were then designated as the Stillwater Wildlife Management Area. In 1991, 77,500 acres (121 square miles) of the eastern portion of this area were set aside as the *Stillwater National Wildlife Refuge (NWR)*. The management area also borders on the north with the *Fallon National Wildlife Refuge*. Today, the Stillwater Wildlife Management Area, along with its two adjoining National Wildlife Refuges, includes a variety of habitats, from freshwater sloughs and marshes to brackish-water marshes and alkali flats. Each habitat hosts a unique assemblage of plants and invertebrates, which in turn attracts more than 160 bird species and many other animals. Also see *National Wildlife Refuges [Nevada]*.

Stochastic — (1) Generally, behavior based on some external influence which may be statistically predictable. (2) Based on the assumption that the actions of a chemical substance results from probabilistic events.

Stochastic Hydrology — That branch of *Hydrology* involving the manipulation of statistical characteristics of hydrologic variables with the aim of solving hydrologic problems, using the stochastic properties of the events.

Stochastic Process — (Statistics) A process in which the dependent variable is random (so that the prediction of its values depends on a set of underlying probabilities) and the outcomes at any instant is not known with certainty. A process is said to be stochastic when its future cannot be predicted exactly from its past; describing an event or process that involves random chance or probability. A stochastic relationship is assumed to be inexact and therefore involves a *Disturbance (or Error) Term* which is used to account for the unexplainable portion of the relationship. Consequently, a simple (stochastic) functional relationship shows that for any time period, t (where $t=1, 2, \dots, n$), the relationship between the dependent (*Endogenous*) variable, Y , and the independent (*Exogenous*) variable, X , may be written as:

$$Y_t = \alpha + \beta X_t + \varepsilon_t$$

where:

Y represents the dependent variable of variable to be explained;

t represents time periods of observation (i.e., $t=1, 2, \dots, n$);

α (*alpha*) represents the constant term (without a time reference);

β (*beta*, also a constant term without a time reference) represents the coefficient of the independent variable, X ;

X represents the independent, or explanatory variable; and

ε (*epsilon*), the error term, represents the value of the unexplained disturbance term.

Contrast with *Deterministic Process*.

Stock Resources Versus Flow Resources — Stock resources are resources that can be permanently expended, and are therefore non-renewable, and whose quantity is usually expressed in absolute amounts rather than in rates. Examples are coal and petroleum deposits. Flow resources are not permanently expendable, i.e., they are renewable, under usual circumstances; they are resources that are replaced. They are commonly expressed in annual rates at which they are regenerated. Examples are fresh-water runoff and timber.

Stock Watering — Watering of animals as follows: (1) Domestic and other farm animals; and (2) Livestock in confinement feeding operations that do not exceed reasonable domestic use.

Stockpond — An impoundment, the principal purpose of which is to supply water to livestock. May include reservoirs, pits, and tanks.

Stoma — (Botany) One of the minute pores in the epidermis of a leaf or stem of plants through which gases and water vapor pass. Also referred to as *Stomate*.

Stomates — The minute openings in the underside (generally) of leaves that permits passage of gases, including oxygen, carbon dioxide, and water vapor.

Stone — Rock fragments larger than 25.4 cm (10 inches) but less than 60.4 cm (24 inches).

Stopcock — A valve that regulates the flow of fluid through a pipe; a faucet.

Stoplogs — Large logs or timber or steel beams placed on top of each other with their ends held in guides on each side of a channel or conduit providing a temporary closure versus a permanent bulkhead gate.

Stopper — In a river system, a reversal powerful enough to stop a raft momentarily. Also called a *Stopper Wave*. See *Keeper*.

Storage — (1) Water artificially impounded in surface or underground reservoirs for future use. (2) Water naturally detained in a drainage basin, such as groundwater, channel storage, and depression storage. The term *Drainage Basin Storage*, or simply *Basin Storage*, is sometimes used to refer collectively to the amount of water in natural storage in a drainage basin. (3) (Water Quality) The temporary holding of waste pending treatment or disposal, as in containers, tanks, waste piles, and surface impoundments.

Storage Capacity, Active (Usable) — The volume of water normally available for release from a reservoir below the stage of the maximum controllable level; equal to total capacity less inactive and dead capacity.

Storage Capacity, Conservation — Storage capacity available for all useful purposes such as municipal water supply, power, irrigation, recreation, fish and wildlife, etc., excluding joint and exclusive flood control capacity.

Storage Capacity, Dead — The volume of a reservoir below the sill or invert of the lowest outlet.

Storage Capacity, Exclusive Flood Control — The space in reservoirs reserved for the sole purpose of regulating flood inflows to abate flood damage.

Storage Capacity, Inactive — The portion of capacity below which the reservoir is not normally drawn, and which is provided for sedimentation, recreation, fish and wildlife, aesthetic reasons, or for creation of a minimum controlled operational or power head in compliance with operating agreements or restrictions.

Storage Capacity, Joint Use — The volume of a reservoir available to store water jointly for flood control and conservation purposes.

Storage Capacity, Live — The volume of a reservoir exclusive of dead and surcharge capacity.

Storage Capacity, Sediment — The volume of a reservoir planned for the deposition of sediment.

Storage Capacity, Surcharge — The volume of a reservoir between the maximum water surface elevation for which the dam is designed and the crest of an uncontrolled spillway, or the normal full-pool elevation with the crest gates in the normal closed position.

Storage Capacity, Total — The total volume of a reservoir exclusive of surcharge.

Storage Coefficient — (1) For surface water, the relation of storage capacity in a reservoir to the mean annual flow of a stream above the dam forming the reservoir. (2) For groundwater, primarily in a *Confined Aquifer*, it is a measure of the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. This definition is similar to that of the *Specific Yield* for a water-table aquifer. However, confined aquifers remain saturated at all times and therefore water release is not met by drainage of the void spaces as is the case of an *Unconfined Aquifer*, but due to the change in pore pressure. Also referred to as the *Storativity*.

Storage Equation — An equation applied to the routing of floods through a reservoir or stream reach, stating that the rate of inflow minus the rate of outflow to a particular area is equal to the change in storage. Also see *Water Budget*.

Storage Ratio — The net available storage divided by the mean flow for one year.

Storage-Required Frequency Curve — A graph showing the frequency with which storage equal to or greater than selected amounts will be required to maintain selected rates of regulated flow.

Storage Reservoir — A reservoir that has space for retaining water from springtime snowmelt or other hydrologic events. Retained water is released as necessary for multiple uses — power production, fish passage, irrigation, navigation, municipal and industrial, etc. Compare to a *Run-of-River Dam*.

Storage Right — The authority granted by a responsible state entity to impound water in a reservoir.

Storage, Specific (Groundwater) — The amount of water released from or taken into storage per unit volume of a porous medium per unit change in head.

Storage, Usable — The volume of water normally available for release from a reservoir below the stage of the maximum controllable level.

Storativity — (1) The amount of water an aquifer will release from storage. (2) The volume of water that a permeable unit, i.e., aquifer, will absorb or expel from storage per unit surface area per unit change in head. In an unconfined aquifer, the storativity value is equal to the *Specific Yield*. The specific yield of the aquifer can be used to estimate the time between when pumping begins and equilibrium groundwater conditions are reached.

Storm — (1) An atmospheric disturbance manifested in strong winds accompanied by rain, snow, hail, or other precipitation and often by thunder and lightning. (2) (Meteorology) A wind with a speed from 64 to 73 miles (from 103 to 117 kilometers) per hour, according to *Beaufort's Scale*. Also referred to as *Violent Storm*.

Storm, Design — The rainfall or precipitation amount and distribution adopted over a given drainage area, used in determining the *Design Flood*.

Storm Loss — Infiltration plus depression storage; may also include interception loss.

Storm Seepage — That part of precipitation which infiltrates the surface soil, and moves toward the streams as ephemeral, shallow, perched groundwater above the main ground-water level. Storm seepage is usually part of the direct runoff. Also referred to as *Interflow*.

Storm Sewer — (1) A sewer that collects and transports surface runoff to a discharge point (infiltration basin, receiving stream, treatment plant). (2) A sewer that carries only surface runoff, street wash, and snow melt from the land. In a separate sewer system, storm sewers are completely separate from those that carry domestic and commercial wastewater (sanitary sewers). Contrast with *Combined Sewer*.

Storm Surge — The rise in the level of the ocean that results from the decrease in atmospheric pressure associated with hurricanes and other storms.

Stormwater Drainage System — Man-made and natural features which function as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate, or divert stormwater runoff.

Stormwater Management — Stormwater management is the mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Stormwater Management Facilities — Stormwater management facilities are those facilities, including but not limited to, stormwater retention and detention ponds and *Best Management Practices (BMPs)*, which retain water for a period of time to control runoff and/or improve the quality (i.e., by reducing the concentration of nutrients, sediments, hazardous substances and other pollutants) of stormwater runoff.

Stormwater Runoff — The water and associated material draining into streams, lakes, or sewers as the result of a storm.

Stoss — Facing the direction from which a glacier moves. Used of a rock or slope in its path.

STP — Sewage Treatment Plant.

Strainer — In a river, brush, fallen trees, bridge pilings, or anything else that allows the current to sweep through but pins boots and boaters.

Strait, also Straits — A narrow channel joining two larger bodies of water.

Straits of Florida — (Oceanography) the water passage between Florida and Cuba, through which the Florida Current flows before it joins the Gulf Stream.

Strand — The land bordering a body of water; a *Beach*.

Strand Line, also Strandline — A shoreline, especially one marking an earlier and higher water level, as caused by a decline in the surface waters of a lake.

Strata — (Geology) Sedimentary rock layers. Distinct horizontal layers in geological deposits. Each layer may differ from adjacent layers in terms of texture, grain size, chemical composition, or other geological criteria. The term is also applied to layering of other material such as the atmosphere.

Stratification — (1) The arrangement of water masses in a lake or other body of water into two or more horizontal layers having different characteristics. (2) The formation of separate layers (of temperature, plant, or animal life) in a lake or reservoir. Each layer has similar characteristics such as all water in the layer has the same temperature. Also see *Thermal Stratification*. (3) The arrangement of a body of water, such as a lake, into two or more horizontal layers of differing characteristics, such as temperature, density, etc. Also applies to other substances such as soil and snow, etc. (4) The formation of layers in snow, ice, or firn as a result of snow sedimentation or other processes. (5) (Geology) A process in which sedimentary material forms, accumulates, or is deposited in layers.

Stratification — (Statistics) The subdivision of a *Population* into groups or strata, each of which is more homogeneous in respect to the variable being measured than the population as a whole. Also see *Stratified Random Sample*.

Stratified Random Sample — (Statistics) A randomized sample composed of two or more sets of random samples, each drawn from a single homogeneous unit (stratum) of a heterogeneous population. Also see *Stratification*.

Stratigraphy — (1) The branch of geology which treats the formation, composition, sequence and correlation of the layered rocks as parts of the earth's crust. (2) The branch of geology that deals with the definition and description of major and minor natural divisions of rocks (mainly sedimentary, but not excluding igneous and metamorphic) available for study in outcrop or from subsurface, and with the interpretation of their significance in geologic history. It involves interpretation of features of rock strata in terms of their origin, occurrence, environment, thickness, lithology, composition, fossil content, age, history, paleogeographic conditions, relation to organic evolution, and relation to other geologic concepts. (3) The arrangement of strata, especially as to geographic position and chronological order of sequence.

Stratocumulus — A low-lying cloud formation occurring in extensive horizontal layers with rounded summits. Also see *Cloud*.

Stratopause — The boundary in the *Atmosphere* between the *Stratosphere* and the next highest layer, the *Mesosphere*.

Stratosphere — (1) The second lowest layer of the atmosphere; characterized by more or less isothermal conditions and a highly stable stratification. The stratosphere extends from about 7 to 20 miles above the earth's surface and contains little moisture or dust but most of the ozone. (2) The region of atmosphere above the *Troposphere* and below the *Mesosphere*.

Stratum — A horizontal layer or section.

Stratus — A low altitude cloud typically resembling a horizontal layer of fog. Also see *Cloud*.

Stream — A general term for a body of flowing water; natural water course containing water at least part of the year. In *Hydrology*, the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term *Stream Gaging*, it is applied to the water flowing in any channel, natural or artificial. Some classifications of streams include, *in relation to time*:

- [1] **Ephemeral Streams** — Streams which flow only in direct response to precipitation and whose channel is at all times above the water table.
- [2] **Intermittent or Seasonal Streams** — Streams which flow only at certain times of the year when it receives water from springs, rainfall, or from surface sources such as melting snow.
- [3] **Perennial Streams** — Streams which flow continuously.

And, *in relation to groundwater*:

- [4] **Gaining Streams** — Streams or a reach of a stream that receive water from the zone of saturation. Also referred to as an *Effluent Stream*.
- [5] **Insulated Streams** — Streams or a reach of a stream that neither contribute water to the zone of saturation nor receive water from it. Such streams are separated from the zones of saturation by an impermeable bed.
- [6] **Losing Streams** — Streams or a reach of a stream that contribute water to the zone of saturation. Also referred to as an *Influent Stream*.
- [7] **Perched Streams** — Perched streams are either losing streams or insulated streams that are separated from the underlying groundwater by a zone of aeration.

Stream Adjudication — See *General Stream Adjudication*.

Stream Bed (also Streambed) — The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream Capture — The process whereby a stream rapidly eroding headward cuts into the divide separating it from another drainage basin, and provides an outlet for a section of a stream in the adjoining valley. The lower portion of the partially diverted stream is called a *Beheaded Stream*. Also referred to as *Stream Piracy*.

Stream Channel — The bed where a natural stream of water runs or may run; the long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.

Stream-Channel Form Ratio — The mathematical relationship between the volume and the perimeter of a *Stream Channel*.

Stream Channel Morphology (Geindicator) [GCRIQ] — Channel dimensions reflect magnitude of water and sediment discharges. In the absence of hydrologic and streamflow records, an understanding of stream morphology can help delineate environmental changes of many kinds. Changes in stream pattern, which can be very rapid in arid and semi-arid areas, place

significant limits on land use, such as on islands in braided streams and meander plains, or along banks undergoing erosion. Alluvial streams (rivers) are dynamic landforms subject to rapid change in channel shape and flow pattern. Water and sediment discharges determine the dimensions of a stream channel (width, depth, and meander wavelength and gradient). Dimensionless characteristics of stream channels and types of pattern (braided, meandering, straight) and sinuosity are significantly affected by changes in flow rate and sediment discharge, and by the type of sediment load in terms of the ratio of suspended to bed load. Dramatic changes in stream bank erosion within a short time period indicate changes in sediment discharge. Because changes in alluvial channel cross-section, especially width, may indicate change in the discharge characteristics of the stream, known discharges can be expressed as a simple power relation with respect to the channel's width, or

$$Q = aW^b$$

where:

Q = discharge;

a = a coefficient;

W = channel width; and

b is an exponent

At ungauged stream sites, therefore, measurements of channel morphology can lead to indirect estimates of discharge, which, if varying with time, may indicate changes in mean discharge or in the occurrence of floods at specific recurrence intervals. See *Geoindicators* [U.S. Global Change Research Information Office].

Stream Channelization — The manipulation of a stream channel to increase the rate of water flow through the stream channel. Manipulation may include deepening, widening, straightening, armoring, or other activities that change the stream cross-section or other aspects of stream channel geometry to increase the rate of water flow through the stream channel. A channelized stream remains a water of the United States, despite the modifications to increase the rate of water flow.

Stream Clearance — The removal of natural or man-caused debris from stream channel areas by mechanical means.

Stream, Coldwater — A stream that supports a coldwater fishery, usually including trout, typically with optimum temperatures of 50E–60EF (10E–15.5EC).

Stream, Coolwater — A stream that supports a coolwater fishery, usually including smallmouth bass and/or rock bass, typically with optimum temperatures of 60E–70EF (15.5E–21EC).

Stream Current — (1) A steady current within a river or stream. (2) A more or less narrow, deep, fast-moving ocean current.

Stream, Effluent — A stream or reach of a stream fed by groundwater. It is also referred to as a *Gaining Stream*. See *Stream*.

Stream, Ephemeral — A stream that flows only in response to precipitation. See *Stream*.

Stream Frequency — A measurement of topographic texture, equal to the ratio between the number of streams in a given drainage basin and the area of the basin. Also referred to as *Channel Frequency*.

Stream Gaging — The quantitative determination of stream flow using *Gages*, *Current Meters*, *Weirs*, or other measuring instruments at selected locations.

Stream-Gaging Station — A gaging station where a continuous record of the discharge of a stream is obtained.

Stream Gradient — (1) A general slope or rate of change in vertical elevation per unit of horizontal distance of the water surface of a flowing stream. (2) The shape of a stream bed, equal to the angle between a horizontal plane and the water surface or channel floor of the stream, measured in the direction of flow. Also referred to as *Stream Slope*.

Stream Gradient Ratio — The ratio of the stream gradient of a stream channel of one order to the gradient of the next higher order channel within the same drainage basin. Also referred to as *Channel Gradient Ratio*.

Stream, Influent — A stream that contributes water to the *Zone of Saturation*. Also referred to as a *Losing Stream*. See *Stream*.

Stream, Intermittent — A stream that flows only part of the time or through only part of its reach. See *Stream*.

Stream-Length Ratio — Within a particular drainage basin, the ratio of the average stream length of a given *Stream Order* to the average stream length of the next lowest order stream.

Stream Load — (1) The total material, other than water, that is actually carried by a stream. (2) The total material that is transported past a given point in a stream at a given time, or over a given period of time. (3) All the material transported by a stream or river either as visible sediment (*Bed Load* and *Suspended Load*) or in solution (*Dissolved Load*).

Stream Meander — See *Meandering Channels*.

Stream Order — (1) Designation of stream segments within a drainage basin; a system of numbering streams according to sequence of tributary size. The smallest perennial tributary is designated as order 1, the junction of two first-order streams produces a stream segment of order 2, etc. (2) A method of numbering streams as part of a drainage basin network as adopted by the U.S. Geological Survey (USGS). The smallest unbranched mapped tributary is a first-order stream, the stream receiving the tributary is a second-order stream, and so on, with the main stream always of the highest order. It is usually necessary to specify the scale of the map used, as a first-order stream on a 1:62,500 map may be a third-order stream on a 1:12,000 map. Tributaries which have no branches are designated as of the first order, streams which receive only first-order tributaries are of the second order, larger branches which receive only first-order and second-order tributaries are designated third order, and so on, the main stream being always of the highest order. Also referred to as *Channel Order*.

Stream, Perennial — A stream that flows continuously. See *Stream*.

Stream Piracy — The process whereby a stream rapidly eroding headward cuts into the divide separating it from another drainage basin, and provides an outlet for a section of a stream in the adjoining valley. The lower portion of the partially diverted stream is called a *Beheaded Stream*. Also referred to as *Stream Capture*.

Stream Power — Measure of energy available to move sediment, or any other particle in a stream channel. It is affected by discharge and slope.

Stream Profile — A line representing the upper edge of a vertical section of a stream that follows the winding of the valley along the length of the stream from its source to its mouth. Also referred to as *Longitudinal Profile* or *River Profile*.

Stream Reach — The continuous portion of a stream channel and adjoining floodplain from one selected point to another, usually measured along the *Thalweg* of the channel.

Stream Sediment Storage and Load (Geoindicator) [GCRIO] — Sediment load determines channel shape and pattern. Changes in sediment yield reflect changes in basin conditions, including climate, soils, erosion rates, vegetation, topography and land use. Fluctuations in sediment discharge affect a great many terrestrial and coastal processes, including ecosystem responses, because nutrients are transported together with the sediment load. For example, to reproduce effectively, salmon and trout need gravel stream beds for spawning and egg survival; silt and clay deposits formed by flooding or excessive erosion can destroy these spawning beds. Stream deposits also represent huge potential sinks for, and sources of, contaminants. The load (discharge, tonnes/year) or yield (tonnes/km²/year) of sediment (in suspension and as bed load of sand and gravel) through stream (river) channels reflects upland erosion within the drainage basin and change in storage of sediment in alluvial bottomlands. In turn, this is influenced by climate, vegetation, soil and rock type, relief and slope, and human activities such as timber harvesting, agriculture, and urbanization. Much of the sediment eroded from upland areas is deposited (stored) on lower hillslopes, in bottomlands, and in lakes and reservoirs. In terms of sediment budget, net erosion = total denudation - sediment storage + channel erosion, where denudation is a measure of regional upland erosion. Flash floods in ephemeral desert streams may transport very large sediment loads, accounting for unforeseen sedimentation problems in dryland stream reservoirs. See *Geoindicators* [U.S. Global Change Research Information Office].

Stream Segment — (1) The portion of a stream that extends between the junctions of specified tributaries. Also referred to as *Channel Segment*. (2) (Water Planning) Surface waters of an approved planning area exhibiting common biological, chemical, hydrological, natural, and physical characteristics and processes. Segments will normally exhibit common reactions to external stresses, for example, discharge or pollutants.

Stream Slope — See *Stream Gradient*.

Stream Terrace — (1) A surface representing remnants of a stream's channel or flood plain when the stream was flowing at a higher level. Subsequent downward cutting by the stream leaves remnants of the old channel or flood plain standing as a terrace above the present level of the stream. (2) A transversely level erosional remnant of a former axial stream or major desert stream floodplain that slopes in the same direction as the adjacent, incised stream, and is underlain by well sorted and stratified sand and gravel or by loamy or clayey sediments.

Stream Transport — Any of various processes by which weathered and eroded rock material is moved in and by a stream.

Stream Underflow — Percolating water in the bed of a stream, flowing parallel to the stream.

Stream, Underground — A subsurface stream which has all the characteristics of a water-course on the surface – a definite channel with bed and banks, a definite stream of water, and a definite source(s) of supply.

Stream, Warmwater — A stream that supports a warmwater fishery, usually including largemouth bass and sunfish, typically with spawning temperatures in excess of 70°F (21°C).

Streambank Erosion — (1) The wearing away of streambanks by flowing water. (2) The removal of soil particles from a bank slope primarily due to water action. Climatic conditions, ice and debris, chemical reactions, and changes in land and stream use may also lead to bank erosion.

Streambank Erosion Control — Vegetative or mechanical control of erodible stream banks, including measures to prevent stream banks from caving or sloughing, such as jetties, revetments, riprap and plantings necessary for permanent protection.

Streambank Erosion Damage — Value of land areas destroyed, reduced value of land due to threat of future erosion, and the destruction or damage of wildlife habitat, buildings, bridges, utilities, or other structures.

Streambank Protection Works — Structure place on or near a distressed stream bank to control bank erosion or prevent failure.

Streambanks — The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream (in the direction of flow).

Streambank Stabilization — Natural geological tendency for a stream to mold its banks to conform with the channel of least resistance to flow. Also the lining of streambanks with riprap, matting, etc., to control erosion.

Streambed (also Stream Bed) — The channel through which a natural stream of water runs or used to run, as a dry streambed.

Streambed Erosion — The movement of material, causing a lowering or widening of a stream at a given point or along a given reach.

Streamflow — The discharge that occurs in a natural channel. Although the term “discharge” can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream course. Streamflow is a more general term than “runoff” as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Streamflow (Geoindicator) [GCRIO] — Streamflow directly reflects climatic variation. Stream systems play a key role in the regulation and maintenance of biodiversity. Changes in streams and streamflow are indicators of changes in a water basin's dynamics and land use. One estimate has put the total annual losses to the economy from flooding of river and coastal plains worldwide at \$20 billion (U.S.). Streamflow varies with the volume of water, precipitation, surface temperature, and other climatic factors. For most streams (rivers), the highest water discharge is found close to the sea, but in arid regions discharge decreases naturally downstream. Land use in drainage basins also strongly affects streamflow. For a given area of one square kilometer (km²), the water discharge (specific run-off) may range from less than 0.1 liter per second to greater than 50 liters per second. Major streamflow regimes include:

[1] **Glacial** – ice melt: regular high water period in early summer, with annual mean discharge (q) = 10-20

liters/second/km²);

[2] **Nival** – snow melt: late spring high water, with discharge (q) = 3-15 liters/second/km²;

[3] **Pluvial** – high water in late autumn-winter, with discharge (q) = 5-20 liters/second/km²;

[4] **Dry Tropical** – high water in summer rainy season, with discharge (q) = 0.5-10 liters/second/km²;

[5] **Monsoon** – discharge (q) = 20-40 liters/second/km²;

[6] **Equatorial** – high water during two rainy periods, with discharge (q) = 15-30 liters/second/km²; and

[7] **Desert** – non-perennial flow, with discharge (q) <0.5 liter/second/km².

Reversals in streamflow, in conjunction with indirect methods of paleoflood studies and paleohydrology, yield long-term indicators of changes in discharge that are valuable for responses to flooding, estimating long-term trends in water and sediment discharges, and for distinguishing possible long-term climate change. See *Geoindicators [U.S. Global Change Research Information Office]*.

Streamflow Depletion — The amount of water that annually flows into a valley or onto a particular land area minus the amount that flows out of the valley or away from the particular land area. It is also the amount of water taken from a stream.

Streamflow Regulation — The artificial manipulation of the flow of a stream.

Streamflow Routing — A technique used to compute the effect of channel storage on the shape and movement of a flood wave.

Streaming Flow — See *Tranquil Flow*.

Streamlet — A small stream.

Streamline (Flowline) — (1) A line that is parallel to the direction of flow of a fluid at a given instant. (2) The path followed by a particle of water as it moves through a saturated soil mass.

Streamside Management Zone (SMZ) — A designated zone that consists of the stream and an adjacent area of varying width where management practices that might affect water quality, fish, or other aquatic resources are modified. It is a zone which acts as an effective filter and adsorptive zone for sediment; maintains shade; protects aquatic and terrestrial riparian habitats; protects channel and streambanks; and promotes floodplain stability. The zone may be wider than just the riparian area.

Streeter-Phelps Equation — (Water Quality) A means of predicting the effects upon dissolved oxygen levels of organic loading to a stream based on the deaeration and reaeration rates, and resulting in an *Oxygen Sag Curve*.

Stress — Growing conditions that endanger a plant or animal's health. Examples include lack of water, too much heat, wind or moisture, or low temperatures. The stressful condition varies according to the particular plant and its needs. Also see *Stressors* and *Ecosystem Stress*.

Stressed Waters — A portion of an aquatic environment with poor species diversity due to human actions. If a facility applying for a water permit will discharge into an aquatic system that is stressed by the actions of others, then it will not be held responsible for the existing poor conditions but must demonstrate to the environmental agency issuing the permit that further degradation will not occur as a result of its effluent.

Stressors — Actions, influences, or effects on an *Ecosystem*, human induced or otherwise, which lead to its deterioration or degradation as a habitat for plant and animal species. Also see *Stress* and *Ecosystem Stress*.

Stretch — (1) A continuous, uninterrupted expanse of water. (2) A portion of river located between two points; a section or a *Reach*.

Striation — One of a number of parallel lines or scratches on the surface of a rock that were inscribed by rock fragments embedded in the base of a glacier as it moved across the rock.

Stringer — A long, narrow line of vegetation, usually following a stream channel or bottom of a draw.

Strip Cropping — (1) Growing crops in a systematic arrangement of strips or bands that serve as barriers to wind and water erosion. (2) A crop production system that involves planting alternating strips of row crops and close-growing forage crops; the forage strips intercept and slow runoff from the less protected row crop strips.

Strip Mining — (1) The mining of coal by surface mining methods as distinguished from the mining of metalliferous ores by surface mining methods, known as *Open-Pit Mining*. (2) The process of removing mineral deposits that are found close enough to the surface so that the construction of tunnels (underground mining) is not necessary. The soil and strata that cover the deposit are removed to gain access to the mineral deposit. The primary environmental concerns related to this technique are the disposition of spoils removed to gain access to the deposit and the scoring of the landscape that remains following the complete removal of the mineral deposit. Water pollution is also a concern because runoff from the mining area is frequently rich in sediments and minerals. Furthermore, such operations sometimes necessitate the removal of groundwater that infiltrates the mining pit, consequently altering the groundwater flow with potential implications on the water table and aquifer characteristics. Also referred to as *Surface Mining*.

Stripping — Methods for the removal of unwanted dissolved gases from water. Stripping techniques involve increasing the surface area of the water to be stripped and maintaining the atmospheric partial pressure of the gas(es) to be removed at a low level relative to the partial pressure of the gas dissolved in the water. Oxygen, ammonia, hydrogen sulfide, volatile organic compounds, and carbon dioxide are commonly stripped from water. Also referred to as *Air Stripping*.

Structural Deformation — The distortion in walls of a tank after liquid has been added or removed.

Structural Floodplain Management Measures — Those physical or engineering measures employed to modify the way floods behave, e.g., dams, dikes, levees, channel enlargements and diversions.

Structural Measures — Measures that delay, reduce, or control flood flows. These measures include reservoirs, channel improvements, levees, and diversion channels.

Stubble Mulching — The management of plant residues by harvesting, tilling, planting, and cultivating in such a way so as to keep protective amounts of vegetation on the soil surface.

Sub-Basin — (1) A portion of a subregion or basin drained by a single stream or group of minor streams. (2) The smallest unit into which the land surface is subdivided for hydrologic study purposes.

Subaqueous — Existing, formed, or taking place in or under water.

Subartesian Water — Confined *Groundwater* that is under sufficient pressure to rise above the water table but not to reach the ground surface as a subartesian well.

Subclimax — (Ecology) A stage in the ecological succession of a plant or animal community immediately preceding a *Climax*, and often persisting because of the effects of fire, flood, or other conditions.

Subcritical Flow — See *Tranquil Flow*.

Subduction Zone — According to the theory of *Plate Tectonics*, a region at the boundary of two of the plates that form the crust of the earth where one of the plates is forced downward into the mantle. The deep ocean trenches off the Pacific coasts of Mexico and South America are examples of these regions. These zones are also referred to as *Convergent Plate Boundaries*.

Subglacial — Formed or deposited beneath a glacier.

Subhumid Climate — Regions where moisture is normally less than under humid conditions but still sufficient for the production of many agricultural crops without irrigation or dryland farming. Natural vegetation is mostly tall grasses. Annual rainfall varies from 20 inches (50.8 centimeters) in cool regions to as much as 60 inches (152.5 centimeters) in hot areas.

Subirrigation (Subirrigate) — (1) Irrigation below the surface (as by a periodic rise of the water table or by a system of underground porous pipes). (2) Irrigation of crops from water table(s) that are in turn supplied by seepage from above-lying canals, laterals, reservoirs, or irrigated fields.

Subirrigated Land — Land with a high water table condition, either natural or artificially controlled, that normally supplies a crop irrigation requirement.

Sublimation — (1) The transformation of a solid to the gaseous phase without passing through the normally intermediate liquid phase. (2) The change of a solid to a vapor (or the reverse) without the appearance of a liquid state, as in the changing of snow directly into water vapor without melting.

Sublittoral — (1) Situated, occurring, or formed on the aquatic side of a shoreline or *Littoral Zone*. (2) The deeper part of the *Littoral* portion of a body of water. (3) The region in a lake between the deepest-growing rooted vegetation and the part of the lake below the *Thermocline*. (4) The region in an ocean between the lowest point exposed by a low tide and the margin of the *Continental Shelf*. (5) (Oceanography) The benthic environment from the extreme low-water level to around 200 meters (660 feet) deep, that is, from the lowest tide area to the edge of the continental shelf. (6) (Ecology) Relating to or describing an organism living immediately below low-tide level.

Sublittoral Zone — (1) The part of the shore from the lowest water level to the lower boundary of plant growth; the transition zone from the *Littoral* to *Profundal* bottom. (2) (Ecology) The deeper part of a lake below the area in which rooted plants grow. (3) (Oceanography) The benthic environment from the extreme low-water level to around 200 meters (660 feet) deep, that is, from the lowest tide area to the edge of the *Continental Shelf*.

Submarine — (1) Beneath the surface of the water; undersea. (2) A ship capable of operating submerged.

Submarine Spring — A freshwater spring that emerges off the seashore.

Submeander — A small meander contained within the banks of a main channel, associated with relatively low discharges.

Submerge — To place under or cover with water or the like; plunge into water, inundate

Submerged Aquatic Vegetation (SAV) — Vegetation such as sea grasses that cannot withstand excessive drying and therefore live with their leaves at or below the water surface. Such vegetation constitutes an important habitat for young fish and other aquatic organisms. Also referred to as *Submerged Plants*.

Submerged Plants — Aquatic vegetation that has roots, stems, and leaves. The plants are rooted in the bottom of a water course but the leaves remain submerged below the surface of the waters. Also referred to as *Submerged Aquatic Vegetation*.

Submergence — (1) The distance between the water surface and the media surface in a filter. (2) Condition of a *Weir* when the elevation of the water surface on the downstream side is equal to or higher than that of the weir crest. (3) A term which implies that part of the land has become inundated by the sea.

Submergent Plant — A vascular or nonvascular *Hydrophyte*, either rooted or nonrooted, which lies entirely beneath the water surface, except for flowering parts in some species; e.g., wild celery (*Vallisneria americana*) or the stoneworts (*Chara* spp.).

Submergible — That which can be immersed in or can remain under water.

Submersed — (1) Under water, submerged; growing under water. (2) (Botany) Growing or remaining under water.

Submersible — (Nautical) A vessel capable of operating or remaining under water, especially a submarine.

Subsequent Stream — A tributary stream flowing along beds of less erosional resistance, parallel to beds of greater resistance. Its course is determined subsequent to the uplift that brought the more resistant beds within its sphere of erosion.

Subsidence — (1) Sinking or lowering of a part of the earth's crust. The sinking of the land surface due to a number of factors, of which groundwater extraction is one. (2) A sinking of a large area of the earth's crust. Typically this may result from the over-pumping of a basin's water table and the inability of the soils to re-absorb water from natural or artificial injection. Also frequently results from overdrafts of the aquifer and its inability to fully recharge, a process termed *Aquifer Compaction*. Also see *Land Subsidence*.

Subsoil — Soil material underlying the surface soil.

Substantial Runoff — See *Base Runoff*.

Substrate — (1) The substances used for food by microorganisms in liquid suspension, as in wastewater treatment. (2) The physical surface upon which an organism lives; the surface, natural or artificial, upon which an organism grows or to which it is attached. (3) The layer of material beneath the surface soil. (4) In agriculture, the subsoil or soil layer underlying the normally cultivated surface layer.

Substrate, Artificial — (1) A device placed in the water for a specified period of time that provides living spaces for a multiplicity of organisms; for example, glass slides, concrete blocks, multi-plate samplers, or rock baskets; used primarily to collect organisms

in areas where the physical habitat is limiting or cannot be adequately sampled using conventional methods. (2) A device which is purposely placed in a stream or lake for colonization of organisms. The artificial substrate simplifies the community structure by standardizing the substrate from which each sample is taken. Examples of artificial substrates are basket samplers (made of wire cages filled with clean streamside rocks) and multiplate samplers (made of hardboard) for benthic organism collection, and plexiglass strips for periphyton collection.

Substrate, Natural — Any naturally occurring immersed or submersed solid surface, such as a rock or tree, upon which an organism lives.

Subsurface — Of, relating to, or situated in an area beneath a surface, especially the surface of the earth or of a body of water.

Subsurface Current — (Oceanography) An ocean current flowing beneath the surface, usually below the main thermocline and often in a different direction from that of the surface currents.

Subsurface Drainage — (1) The process of directing excess water away from the root zones of plants by natural or artificial means, such as by using a system of pipes and drains placed below ground surface level. (2) The water drained away from irrigated farmland. Also referred to as *Agricultural Drainage*.

Subsurface Drainage System — A system of underground pipes to remove excess water accumulating below the soil surface that will not naturally percolate out of the root zone.

Subsurface Drains — Subsurface drains are buried, perforated pipelines designed to collect and convey subsurface water from an irrigated area.

Subsurface Flow — (1) Water which infiltrates the soil surface and moves laterally through the upper soil layers until it enters a channel. (2) Water moving through the sands and gravels under or next to a stream channel and considered to be part of the stream and subject to the same riparian and appropriative rights that guide the use of the stream itself. Contrast with *Percolating Water*.

Subsurface Flow (SF) Constructed Wetland — A type of constructed wetland, a man-made marsh-like area used to treat wastewater. In the wetland, the effluent flows through a bed of rock or gravel, with the water level remaining below the surface of the gravel bed. Among the advantages of this type of system are its lack of odors, low potential for insect breeding, and minimal risk of public exposure and contact with the water in the system. Contrast with *Free Water Surface (FWS) Constructed Wetland* in which the water is exposed to the air. Also see *Wetlands, Benefits*.

Subsurface Hydrology — The branch of *Hydrology* dealing with the study of underground water, i.e., *Groundwater*, as opposed to surface water.

Subsurface Irrigation System — Irrigation by means of underground porous tile or its equivalent.

Subsurface Leaching System — (Wastewater Treatment) A method of treatment and disposal of septic tank effluent, sand filter effluent, or other treated wastewater. The effluent is applied to soil below the ground surface through open-jointed pipes or drains or through perforated pipes (holes in the pipes). The effluent is treated as it passes through porous soil or rock strata (layers). Newer subsurface leaching systems include chamber and gravelless systems, and also gravel trenches without pipe the full length of the trench.

Subsurface Runoff — Water that moves through the aerated portion of the soil to the stream and behaves more like overland flow than base flow.

Subsurface Seepage — Subsurface seepage is movement of water through soils from above-lying bodies of water.

Subsurface Water — (1) All water which occurs below the ground surface. (2) Water below the surface of the ground, including soil moisture, intermediate zone water, capillary fringe water, and groundwater. Also referred to as *Underground Water* and *Subterranean Water*.

Subterranean Stream — A stream flowing beneath the surface through a cave or group of connected caves.

Subterranean Water — Water below the surface of the ground. Also referred to as *Underground Water* and *Subsurface Water*.

Subterranean Water (Legal) — Those subsurface waters whose courses are well defined and reasonably ascertainable and whose existence is not temporary.

Subwatershed — Drainage area composed of two or more *Subbasins*.

Succession — (Biology) (1) The ecological process of sequential replacement by plant communities on a given site as a result of differential reproduction and competition. (2) Directional, orderly process of change in a living community in which the community modifies the physical environment to eventually establish an ecosystem which is as stable as possible at the site in question.

Succulent — (Botany) (1) Having thick, fleshy, water-storing leaves or stems. (2) A tropical or desert plant with thick and fleshy stem or leaves designed to retain water and minimize evaporation. Succulent plants are usually found in regions of little rainfall and generally have long roots to absorb a maximum amount of water. Some of the commonest succulents are the cactus, which are leafless or have short, prickly leaves, storing a lot of sap in the stem; and the agave and aloe, which collect water in the stem.

Suction Lift — (1) (Irrigation) The difference in elevation between the water source and the pump. (2) The negative pressure [in feet (meters) of water or inches (centimeters) of mercury vacuum] on the suction side of the pump. The pressure can be measured from the centerline of the pump down to (lift) the elevation of the hydraulic grade line on the suction side of the pump.

Suction Lysimeter — A sampling device for the collection of groundwater from the unsaturated zone. A sample is drawn by applying a negative pressure to a porous ceramic cup embedded in the soil layer.

Suction Pump — A pump for drawing up a liquid by means of suction produced by a piston drawn through a cylinder.

Suffosion — A process by which underground water from partially melted ground ice bursts through the upper surface, carrying with it a deposit of mud, sand, rock, or other such material.

Suitability — (Environmental) The appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences.

- Sulfur Dioxide (SO₂)** — (1) A colorless, irritating gas that is a primary cause of *Acid Rain*. It is a by-product of coal combustion. (2) A colorless, nonflammable, water-soluble, suffocating gas. A pollutant emitted chiefly by industries and blamed for much lung trouble. When combined with water vapor and returned to the earth as precipitation, form a mild form of sulfuric acid.
- Sulfur Stream** — A spring whose water contains sulfur compounds, especially enough hydrogen sulfide to smell and taste.
- Sullage** — (1) Silt deposited by a current of water. (2) Waste materials or sewage; refuse.
- Summer Kill** — The complete or partial kill of a fish population in ponds, lakes, or reservoirs during the warm months caused by a combination of factors to include excessively warm water, a depletion of dissolved oxygen, and the release of toxic substances from a decaying algal bloom. Also see *Winter Kill*.
- Summit** — The flattish top of an erosional fan remnant, hill, mountain, etc. The term is used for both a landform element and a slope component.
- Sump** — (1a) A low-lying place, such as a pit, that receives drainage; (1b) A cesspool. (2) A hole at the lowest point of a mine shaft into which water is drained in order to be pumped out.
- Sump Pump** — (1) A pump designed and so placed in a *Sump* to remove the water or other liquids collected there. (2) Device used to remove water from seepage or rainfall that collects in areas protected by a levee, floodwall, or dry floodproofing. In addition, a sump pump is often part of a standard house drainage system that removes water that collects below a basement slab floor.
- Sun Dog** — See *Parhelion*.
- Sunbow** — A rainbow-like display of colors resulting from refraction of sunlight through a spray of water. Also see *Rainbow*.
- Sunspot Activity** — (Climate) A theory which posits that weather patterns may be caused by the level and timing of sunspot activity. Sunspots represent increased solar (irradiance) activity on the sun's surface that occurs with periodic frequency of, on the average, once every 11.13 years. They last often a month, sometimes for several months, and their appearance is frequently accompanied by magnetic storms on earth. In research by the *National Center for Atmospheric Research* in Boulder, Colorado and the *U.S. Geological Survey (USGS)* in Lawrence, Kansas, researchers have shown a very high probability that the interior of the United States will be dominated by a low pressure system when there is little solar flare (sunspot) activity and the winds high above the equator are blowing from the west. This system results in cold weather in much of the country but warm weather in the Northeast. These researchers have also shown a much higher probability of wet weather in the West four years after a peak of solar irradiance, a peak that occurs, more or less, in conjunction with a peak in sunspot activity. The last recorded period of high sunspot activity was unusual as it was marked by a double peak, one in 1989 and one in 1991.
- Supercapillary Interstice** — (Geology) An interstice, larger than a capillary interstice, that is too large to hold water above a free water surface by surface tension.
- Superchlorination** — *Chlorination* with doses that are deliberately selected to produce water free of combined residuals so large as to require dechlorination.
- Supercool** — To cool a liquid below a transition temperature without the transition occurring, especially to cool below the freezing point of water without solidification into ice.
- Supercooled Water** — Water cooled below its freezing point without causing solidification.
- Supercooling** — The process of cooling a liquid below its normal freezing point in such a manner that it does not freeze. In a cloud of very small water droplets, in the absence of nuclei to initiate freezing, the droplets can be supercooled over 70 degrees below the normal freezing point without crystallizing.
- Supercritical Water** — A type of thermal treatment using moderate temperatures and high pressures to enhance the ability of water to break down large organic molecules into smaller, less toxic ones. Oxygen injected during this process combines with simple organic compounds to form carbon dioxide and water.
- (Hazardous Substances) Superfund** — (1) Federal law which authorizes the *U.S. Environmental Protection Agency (EPA)* to manage the clean-up of abandoned or uncontrolled hazardous waste sites. (2) A federal trust fund for use in the cleanup of spills or sites containing hazardous waste that pose a significant threat to the public health or the environment. The fund, originally called the *Hazardous Substances Response Trust Fund*, was established by the *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* in 1980 to carry out EPA solid waste emergency and long-term removal and remedial activities. Beginning in 1980, \$1.5 billion was to be collected over five years, mainly from taxes on crude oil, petroleum products, petrochemicals, and certain inorganic chemicals. The 1986 re-authorization of the law, which changed the fund's name to the *Hazardous Substances Superfund* (or just "Superfund"), increased the fund to \$8.5 billion and broadened the tax base to include a general corporate Superfund tax. Another one-half billion dollars was included to clean up leaks from underground storage tanks. Also see *U.S. Environmental Protection Agency (EPA)*.
- Superfund Law (Comprehensive Environmental Response, Compensation, and Liability Act — CERCLA)** — This statute, originally enacted in 1980 and substantially modified in 1986, establishes the *U.S. Environmental Protection Agency's (EPA)* authority for emergency response and cleanup of hazardous substances that have been spilled, improperly disposed of, or released into the environment. The primary responsibility for response and cleanup is on the generators or disposers of the hazardous substances, with a backup federal response using a trust fund provision.
- Superfund List** — A list of the hazardous waste disposal sites most in need of cleanup. The list is updated annually by the *U.S. Environmental Protection Agency (EPA)* based primarily on how a site scores using the *Hazard Ranking System*. Also referred to as the *National Priorities List (NPL)*.
- Superfund Site** — A hazardous waste landfill on the *National Priorities List (NPL)* (also referred to as the *Superfund List*) being cleaned up by the responsible parties or using proceeds from the *Hazardous Substances Superfund*.
- Superheated Water** — Liquid water heated above 100EC (212EF) under pressures greater than atmospheric.
- Superimposed Drainage** — A drainage system consisting of *Superimposed Streams*.
- Superimposed Stream** — (1) A stream whose present course was established on young rocks burying an old surface. With uplift,

this course was maintained as the stream cut down through the young rocks to and into the old surface. (2) A stream that developed on a new surface and maintained its course despite the existence of differing geologic structures and lithologies as it eroded downward into the underlying rock strata. Also referred to as *Superinduced Stream*.

Superjacent Waters — (Oceanography) The ocean overlying a *Continental Shelf*.

Supernatant — (1) Floating on the surface. (2) (Water Quality) The clear fluid that is removed from the top of tanks or ponds used to allow solids to settle from suspension. (3) (Wastewater Treatment) Liquid removed from settled sludge. Supernatant commonly refers to the liquid between the sludge on the bottom and the scum on the water surface of a basin or container. Liquid removed from settled sludge. Supernatant commonly refers to the liquid between the sludge on the bottom and the scum on the surface of an *Anaerobic Digester*. This liquid is usually returned to the influent wet well or to the *Primary Clarifier*. Also referred to as *Overflow*.

Supersaturate — (1) To cause (a chemical solution) to be more highly concentrated than is normally possible under given conditions of temperature and pressure. (2) To cause (a vapor) to exceed the normal saturation vapor pressure at a given temperature.

Supersaturated — An unstable condition of a solution (water) in which the solution contains a substance at a concentration greater than the saturation concentration for the substance.

Supersaturated Solution — (Chemistry) A solution that holds more of a dissolved solute than is required to produce equilibrium with its undissolved solute. In nature, bees' honey is an example of a supersaturated solution of sugars (fructose and glucose) in water, formed by the evaporation of some of the water.

Supersaturation — (1) (Chemistry) A condition in which a solution contains more solute than is normally necessary to achieve saturation under the same conditions. (2) (Meteorology) A condition in which the relative humidity is greater than 100 percent, containing more water vapor than needed to produce saturation with respect to a plane surface of pure water or ice; this occurs in the absence of condensation nuclei or other wettable surfaces.

Supplemental Irrigation — When irrigation water supplies are obtained from more than one source, the source furnishing the initial supply is commonly designated the primary source, and the source(s) furnishing the additional supplies, the *Supplemental Sources*.

Supplemental Sources — When irrigation water supplies are obtained from more than one source, the source furnishing the principal supply is commonly designated the primary source, and the sources furnishing the additional supplies, the supplemental sources.

Supplier of Water — Any person who owns or operates a *Public Water Supply System (PWSS)*.

Supply Augmentation Alternatives — Water management programs that increase supply, for example, *Conjunctive Use*, *Water Banking*, or water project facility expansion such as reservoir construction or groundwater extraction.

Supragelisol — See *Suprapermafrost Layer*.

Supralittoral Zone — (Ecology) That portion of the seashore adjacent to the tidal or spray zone. Also referred to as the *Supratidal Zone*.

Suprapermafrost Layer — The layer of ground or soil lying above the *Permafrost*, including the seasonally frozen layer as well as any other frozen or unfrozen ground. Also referred to as *Supragelisol*.

Supratidal — (Ecology) Of or relating to the shore area adjoining and just above the high-tide level. Also referred to as *Supralittoral*.

Supratidal Zone — (Ecology) The region of the shore that is just above the highest water level, within reach of waves or spray. Also referred to as the *Supralittoral Zone*.

Surf — (Oceanography) Ocean waves breaking on the shore or within the area from the shore to the farthest oceanward breaker; wave activity in the *Surf Zone*.

Surf Beat — (Oceanography) A series of irregular oscillations of the nearshore water level, with periods of the order of several minutes, caused by the irregular arrival of groups of relatively large waves.

Surf Zone — (Oceanography) The area between the outermost breakers and the extent of wave uprush. Also referred to as the *Breaker Zone*.

Surface Area (Lake or Impoundment) — That area encompassed by the boundary of the lake or impoundment as shown on *U.S. Geological Survey* topographic maps, or on other available maps or photographs. The computed surface areas reflect the water levels of the lakes or impoundments at the times when the information for the maps or photographs was obtained.

Surface Casing — The well pipe inserted as a lining nearest to the surface of the ground to protect the well from near-surface sources of contamination.

Surface Collecting Agents — Chemical additives spread on oil spills in an aquatic environment to control the thickness of the oil layer.

Surface Compaction — Increasing soil density by applying force at the surface. The process is frequently used in the installation of clay liners to prevent or reduce surface water movement to underground sources.

Surface Current — (Oceanography) (1) A current whose core of maximum velocity is near the surface. (2) A current that extends no more than 3 meters (10 feet) deep in nearshore areas and no more than 10 meters (33 feet) deep in deep water.

Surface Detention — That part of the rain which remains on the ground surface during rain and either runs off or infiltrates after the rain ends; surface detention does not include *Depression Storage*.

Surface Impoundment — (Water Quality) The treatment, storage, or disposal of liquid hazardous wastes, such as in tanks, ponds, pits, or lagoons. An indented area in the land's surface for such storage and treatment.

Surface Irrigation — A water application whereby water is applied to the soil either by controlled flooding or through some kind of furrow.

Surface Loading — One of the guidelines for the design of settling tanks and clarifiers in treatment plants. Used by operators to determine if tanks and clarifiers are hydraulically (flow) overloaded or underloaded. Also called *Over Flow Rate*.

Surface Mining — The process of removing mineral deposits that are found close enough to the surface so that the construction of tunnels (underground mining) is not necessary. The soil and strata that cover the deposit are removed to gain access to the mineral deposit. The primary environmental concerns related to this technique are the disposition of spoils removed to gain access to the deposit and the scoring of the landscape that remains following the complete removal of the mineral deposit. Water pollution is also a concern because runoff from the mining area is frequently rich in sediments and minerals. Furthermore, such operations sometimes necessitate the removal of groundwater that infiltrates the mining pit, consequently altering the groundwater flow with potential implications on the water table and aquifer characteristics. Also referred to as *Open-Pit Mining* or *Strip Mining*. Also see *Dewatering*.

Surface Mining Control and Reclamation Act — An act passed in 1977 requiring that mine operators take measures to avoid acid or other toxic mine drainage. To correct existing acid drainage problems, the section of the law dealing with abandoned mine land states that land and water affected by mining that took place before 1977 can be cleaned up with fees paid by coal operators into the *Abandoned Mine Reclamation Fund*. About 90 percent of existing stream damage in the United States is from underground coal mining that took place before 1977. The federal enforcement agency is the U.S. Department of the Interior, Bureau of Mines, Office of Surface Mining Reclamation and Enforcement (OSM).

Surface Pump — A mechanism for removing water or wastewater from a sump or wet well.

Surface Runoff — (1) Precipitation, snow melt, or irrigation in excess of what can infiltrate the soil surface and be stored in small surface depressions; runoff is a major transporter of non-point source pollutants. (2) That part of the runoff which travels over the soil surface to the nearest stream channel. It is also defined as that part of the runoff of a drainage basin that has not passed beneath the surface since precipitation. Also applies to snowmelt or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions. In terms of surface water quality, surface runoff may constitute a major transporter of *Non-Point Source (NPS) Pollution*. The term is misused when applied in the sense of *Direct Runoff*. Also see *Runoff*, *Direct Runoff*, *Overland Flow*, *Ground-Water Runoff*, and *Surface Water*.

Surface Supply (of Water) — Water supply from streams, lakes, and reservoirs.

Surface Tension — A phenomenon caused by a strong attraction towards the interior of the liquid action on liquid molecules in or near the surface in such a way to reduce the surface area. The tension that results is usually expressed in dynes per centimeter (cm) or ergs per square centimeter (cm²).

Surface Water — (1) An open body of water such as a stream, lake, or reservoir. (2) Water that remains on the earth's surface; all waters whose surface is naturally exposed to the atmosphere, for example, rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc., and all springs, wells, or other collectors directly influenced by surface water. (3) A source of drinking water that originates in rivers, lakes and run-off from melting snow. It is either drawn directly from a river or captured behind dams and stored in reservoirs. Also see *Groundwater Under the Direct Influence (UDI) of Surface Water*.

Surface Water Disposal — Refers to the release of reclaimed water or treated effluent directly into a surface body of water (including marshes and wetlands). This does not include water discharged into ponds for holding or *Percolation* purposes. Also see *Percolation Ponds*.

Surface Water Quality (Geoindicator) [GCRIQ] — Clean water is essential to human survival as well as to aquatic life. Most is used for irrigation, with lesser amounts for municipal, industrial, and recreational purposes: only 6 percent of all water is used for domestic consumption. An estimated 75 percent of the populations of developing nations lacks adequate sanitary facilities, and wastes are commonly dumped into the nearest body of flowing water. Pathogens such as bacteria, viruses and parasites make these wastes among the world's most dangerous environmental pollutants: water-borne diseases are estimated to cause about 25,000 deaths daily. Water quality data are, thus, essential for the implementation of responsible water quality regulations, for characterizing and remediating contamination, and for the protection of the health of humans and aquatic organisms. The quality of surface water in rivers and streams, lakes, ponds and wetlands is determined by interactions with soil, transported solids (organics, sediments), rocks, groundwater and the atmosphere. It may also be significantly affected by agricultural, industrial, mineral and energy extraction, urban and other human actions, as well as by atmospheric inputs. The bulk of the solutes in surface waters, however, are derived from soils and groundwater baseflow where the influence of water-rock interactions are important [see *Groundwater Quality*; *Karst Activity*; *Soil and Sediment Erosion*; *Soil Quality*; *Streamflow*; *Wetlands Extent, Structure and Hydrology*]. Selecting the variables to be measured depends on the objectives and economics of the monitoring. This is a complex matter because there are so many potential chemical, physical and biological substances that could be important in any one area. From the viewpoint of *Geoindicators*, the following variables may be selected:

[1] **Basic Variables (Parameters):**

- Metals and trace elements: Aluminum (Al), Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Selenium (Se), Silver (Ag), Zinc (Zn);
- Nutrients: ammonium, nitrate, nitrite, total Nitrogen (N), orthophosphate, total Phosphorus (P);
- Major constituents and dissolved solids: Calcium (Ca), Magnesium (Mg), Sodium (Na), Chlorine (Cl), SO₄, HCO₃, TDS;
- Direct field measurements: acidity, alkalinity, dissolved Oxygen (O), pH, temperature;
- Selected organic compounds of environmental significance: 2,4-D; 2,4,5-T; phenol, chlorophenols, cresols, atrazine, cyperquat, paraquat, benzidine, DDT, malathion.

[2] **Additional Parameters:**

- Of importance to human health: Barium (Ba), Beryllium (Be), Fluorine (F), Molybdenum (Mo), Nickel (Ni), Vanadium (V), radionuclides (gross alpha, gross beta, ²²²Rn);

- Of importance to agriculture – Boron (B).

Surface Water Supply Index (SWSI) (Drought Index) — Originally developed to complement the *Palmer Drought Severity Index (PDSI)*, the SWSI, unlike the PDSI which is basically a soil moisture index, was designed to be an indicator of surface water conditions in which mountain snowpack is a major component. The intent of the SWSI is to incorporate both hydrological and climatological features into a single index value resembling the PDSI. Four inputs are required for the SWSI: snowpack, streamflow, precipitation and reservoir storage. Because the SWSI calculations are unique to each watershed or defined region, it is difficult to compare SWSI values among these geographic areas. Also see *Drought Indexes (Indices)*.

Surface Water Treatment Rule (SWTR) [EPA] — Water quality treatment standards as prescribed under the *Safe Drinking Water Act (SDWA)* and amendments thereto. The rule is a set of treatment technique requirements enforced by the U.S. Environmental Protection Agency (EPA) which apply to all water systems using surface water and those using groundwater which is under the influence of surface water. Surface water systems are those using water exposed to the atmosphere, such as rivers, lakes, reservoirs, or streams. Groundwater systems that are under the influence of surface water may include shallow wells, infiltration galleries, and springs which may contain the same disease-causing microorganisms of concern in surface water. The rule requires that these systems properly filter the water, unless they can meet certain strict criteria. The rule also requires that these systems disinfect the water. There are no exceptions from the disinfection requirement.

Surface Water Withdrawals — Includes all waters taken from streams, rivers, ponds, lakes, reservoirs, springs and all effluent and other waste water.

Surface Wave — (Oceanography) A progressive gravity wave in which the particle movement within the fluid mass is confined to the upper layers and is greatest at the surface.

Surfactant — (1) The active agent in detergents that possesses a high cleaning ability. (2) An agent that is used to decrease the surface tension of water, useful for removing or dispersing oils or oily residues. Most detergents are surfactants. The term is derived from “surface active agent”. (3) A substance capable of reducing the surface tension of a liquid in which it is dissolved. Used in air-based drilling fluids to produce foam, and during well development to disaggregate clays.

Surficial Bed Material — The top 0.1 to 0.2 feet of the bed material that is sampled using U.S. Series Bed-Material Samplers.

Surge — (1) To move in a billowing or swelling manner in or as if in waves. (2) To roll or be tossed about on waves, as a boat. (3) To move like advancing waves. (4) Waves of pressure that are either positive, higher than the normal pressure level, or negative, below the normal pressure level. (Engineering) (5) A transient change, especially an increase, in the pressure of a hydraulic system. (6) The highest pressure in a system. (7) (Fluid Mechanics) A wave at the free surface of a liquid characterized by a sudden increase in depth of the flow across the wavefront, and severe eddy motion at the wavefront. (Oceanography) (8) An ocean wave motion with a period halfway between that of the tide and that of the ordinary wind wave (roughly 30 seconds to 60 minutes), and of a low height, usually under 10 centimeters. (9) The horizontal oscillation of water with a relatively short period accompanying a *Seiche*. Also see *Storm Surge*.

Surge Chamber — A chamber or tank connected to a pipe and located at or near a valve that may quickly open or close or a pump that may suddenly start or stop. When the flow of water in a pipe starts or stops quickly, the surge chamber allows water to flow into or out of the pipe and minimize any sudden positive or negative pressure waves or surges in the pipe.

Surge Wave — A *Translatory Wave* in an open channel resulting from a sudden change in flow of water, such as that caused by opening or closing a gate.

Surplus Water — Developed water supplies in excess of contract entitlement or apportioned water.

Suspended — Refers to the amount (concentration) of undissolved material in a water-sediment mixture. It is associated with the material retained on a 0.45-micrometer filter.

Suspended Growth Processes — (Wastewater Treatment) Wastewater treatment processes in which the microorganisms and bacteria treating the wastes are suspended in the wastewater being treated. The wastes flow around and through the suspended growths. The various modes of the activated sludge process make use of suspended growth reactors. These reactors can be used for *Biochemical Oxygen Demand (BOD)* removal, *Nitrification* and *Denitrification*.

Suspended Load — (1) Portion of sediment that moves in suspension. (2) All the material transported by a stream or river, neither in contact with the river bottom (*Bed Load*) nor in solution (*Dissolved Load*).

Suspended Particulate Matter — A sample drawn from natural water or from a wastewater stream consists of a mixture of both dissolved and suspended matter. Solid materials retained on a filter prescribed by the specific technique being followed are referred to as particulate matter. The suspended particulate matter can be subdivided into two fractions: volatile and fixed. The volatile particulates are those that are lost when the filter is heated to about 550EC (1,022EF), and the fixed particulates are those that are not lost upon being so heated. The volatile substances are generally considered to be of biological origin, and the fixed solids are considered to be minerals.

Suspended, Recoverable — The amount of a given constituent that is in solution after the part of a representative suspended-sediment sample that is retained on a 0.45-micrometer membrane filter has been digested by a method (usually using a dilute acid solution) that results in dissolution of only readily soluble substances. Complete dissolution of all the particulate matter is not achieved by the digestion treatment and thus the determination represents something less than the “total” amount (that is, less than 95 percent) of the constituent present in the sample. To achieve comparability of analytical data, equivalent digestion procedures are required of all laboratories performing such analyses because different digestion procedures are likely to produce different analytical results. Determinations of “suspended, recoverable” constituents are made either by analyzing portions of the material collected on the filter or, more commonly, by the difference, based on determinations of (1) dissolved and (2) total recoverable concentrations of the constituent.

Suspended Sediment — Very fine soil particles which remain in suspension in water for a considerable period of time without contact with the bottom. Such material remains in suspension due to the upward components of turbulence and currents and/or

by *Colloidal Suspension*.

Suspended-Sediment Concentration — (1) The ratio of the mass of dry sediment in a water-sediment mixture to the mass of the water-sediment mixture. Typically measured at a given distance between the surface of the water and the bed, expressed in milligrams of dry sediment per liter of water-sediment mixture. (2) The velocity-weighted concentration of suspended sediment in the sampled zone (from the water surface to a point approximately 0.3 feet above the bed) expressed as milligrams of dry sediment per liter of water-sediment mixture (mg/L). The entire sample is used for the analysis. Also see *Mean Concentration of Suspended Sediment*.

Suspended-Sediment Discharge — (1) The quantity of suspended sediment passing a transect in a unit of time. When expressed in tons per day, it is computed by multiplying water discharge (in cubic feet per second) by the suspended-sediment concentration (in milligrams per liter) and by the factor 0.0027. (2) The quantity of sediment moving in suspension, reported as dry weight, that passes a cross section in a given time. It is calculated in units of tons per day as follows: concentration (mg/L) X discharge (cubic feet/second) times 0.0027.

Suspended-Sediment Load — A term that refers to material in suspension. The term needs to be qualified, however, such as “annual suspended-sediment load” or “sand-size suspended-sediment load,” and so on. It is not synonymous with either *Suspended-Sediment Discharge* or *Concentration*.

Suspended Solids (SS) — (1) Solids that either float on the surface or are suspended in water or other liquids, and which are largely removable by laboratory filtering. (2) Solids which are not in true solution and which can be removed by filtration. Such suspended solids usually contribute directly to turbidity. Defined in waste management, these are small particles of solid pollutants that resist separation by conventional methods. Suspended solids (along with *Biochemical Oxygen Demand*) is a measurement of water quality and an indicator of treatment plant efficiency. (3) The quantity of material removed from water in a laboratory test, as prescribed in Standard Methods for the Examination of Water and Wastewater. Also see *Suspended Particulate Matter*.

Suspended, Total — The total amount of a given constituent in the part of a representative suspended-sediment sample that is retained on a 0.45-micrometer membrane filter. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent determined. Knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to determine when the results should be reported as “suspended, total”. Determinations of “suspended, total” constituents are made either by analyzing portions of the material collected on the filter or, more commonly, by the difference, based on determinations of (1) dissolved and (2) total concentrations of the constituent.

Suspended Water — Underground water held in the *Zone of Aeration* by molecular attraction exerted on the water by the rock and earth materials and by the attraction exerted by the water particles on one another. It includes seeping water and stored water.

Suspension — A dispersion of solid particles which are large enough to be seen and will settle out on standing. The medium of dispersion is liquid.

Suspensoids — *Colloidal* particles which remain in suspension under all conditions and will combine or react only to a limited extent with the liquid in which they exist.

Sustainability — (Ecosystem) Management practices that do not take more from an ecosystem than it can provide. Theoretically, sustainable management practices can continue in perpetuity, since they do not lead to exhaustion of natural resources.

Sustainable Development — Describes those efforts to guide economic growth, especially in less-developed countries, in an environmentally sound manner, with an emphasis on natural resource conservation.

Sustainable Management — A method of exploiting a resource that can be carried on indefinitely. For example, the removal of water from an aquifer in excess of recharge is, in the long term, not a sustainable management method.

Sustained Overdraft — A long-term withdrawal from the aquifer of more water than is being recharged. Also see *Groundwater Mining*.

Sustained Yield — (1) (General) Achievement and maintenance, in perpetuity, of a high-level annual or regular periodic output or harvest of the various renewable land and water resources. (2) The amount of water that may be removed (say, through groundwater pumping) from an hydrographic area during a period of time without affecting future yields. Under such conditions, sustained yield is approximately equal to annual recharge. Contrast with *Groundwater Mining*. (3) (Ecology) The perpetual output of a renewable resource, achieved and maintained at a given management intensity, without impairment of the productivity of the land.

SVI — See *Sludge Volume Index*.

SW — Surface Water.

Swale — (1) A slight depression, sometimes swampy, in the midst of generally level land. (2) A shallow depression in an undulating ground moraine due to uneven glacial deposition. (3) A long, narrow, generally shallow, trough-like depression between two beach ridges, and aligned roughly parallel to the coastline. (4) A piece of meadow, often a slight depression or valley, as in a plain or moor, marshy and rank with vegetation. Swales usually carry flows only during or immediately after rainfall or snowmelt events. Swales vary in size from small conveyances providing drainage along roadways and behind or between buildings to larger waterways. (Geology) (5) A shallow, sometimes swampy, depression in generally flat or level land. (6) A shallow depression in a gently rolling ground moraine, caused by uneven glacial deposition. (7) A long, narrow, generally shallow, trough-like depression between two beach ridges, oriented generally parallel to the coastline. Also referred to as *Runnel*.

Swallow Hole — (Geology) (1) A hole, cavity, or depression through which a stream disappears underground. (2) An underwater lake outlet.

Swamp — (1) A term frequently associated with *Wetlands*. Wet, spongy land; low saturated ground, and ground that is covered intermittently with standing water, sometimes inundated and characteristically dominated by trees or shrubs, but without appreciable peat deposits. Swamps may be fresh or salt water and tidal or non-tidal. It differs from a *Bog* in not having an acid

substratum. (2) (Ecology) A general term for an area that is waterlogged and covered with abundant vegetation, especially shrubs and trees. (2) (Navigation) To fill with water and sink, as a small boat.

Swash — (1) A splash of water or other liquid hitting a solid surface; (2) The sound made by such a splash. (3) A narrow channel through which tides flow; (4) A bar over which waves wash freely. (Geology) (5) A narrow sound or channel of water within a sandbank or separating a sandbank from the shore. (6) A sandbar that is oriented in such a way that the waves of the sea wash over it. Also referred to as *Swash Bar*. (7) (Oceanography) The uprush of water onto the beach from a wave. Also referred to as *Run-Up*.

Swash Marks — The wavy lines of fine sand or bits of debris left on the beach at the upward limit of the rush of water following the breaking of a wave.

SWCD — Soil and Water Conservation District. See *Soil Conservation District (SCD)*.

Sweet (Water) — (1) Another term for fresh water, which is thought of as sweet in contrast to salt water. (2) Water that is pleasing to the senses; agreeable and not saline or polluted; drinkable; *Potable*. Also see *Freshwater*.

Swell — (1) To rise or extend above the surrounding level, as clouds. To rise in swells, as the sea. (2) A long wave on water that moves continuously without breaking.

Swill — (1) To flood with water, as for washing. (2) Semiliquid waste material consisting of food scraps and free liquids.

Swim (Swimming) — To move through water by means of the limbs, fins, or tail.

Swimmer's Itch — An unpleasant, itchy rash caused by the larval stage of flatworms parasites, called *Schistosomes*. These microscopic worms are found in many lakes and pond inhabited by ducks and snails. They occur usually in the warm summer months when beaches are most heavily used. See *Schistosomiasis* and *Schistosome Cercariae*.

Swimming Pool — Any man-made, contained, or partially-contained structure used for swimming.

SWTR — See *Surface Water Treatment Rule*.

Synecology — (1) The branch of ecology dealing with the relations between plant and animal communities and their environments. (2) The study of different natural communities or *Ecosystems*.

Synergism — An interaction of two or more chemicals which results in an effect that is greater than the sum of their effects taken independently.

Synoptic Oceanography — (Oceanography) The study of ocean phenomena from a comprehensive point of view, using primarily data recorded at a particular time at widely separated places; in recent years, increasingly relying on satellite photography.

Synoptic Studies — Short-term investigations of specific water-quality conditions during selected seasonal or hydrologic periods to provide improved spatial resolution for critical water-quality conditions. For the period and conditions sampled, they assess the spatial distribution of selected water-quality conditions in relation to causative factors, such as land use and contaminant sources.

Synthetic Organic Chemicals (SOCs) — Man-made chemicals containing carbon including pesticides, herbicides, and *Polychlorinated Biphenyls (PCBs)*. The *U.S. Environmental Protection Agency (EPA)* maintains a listing of SOC's that are regulated with respect to *Maximum Contaminant Levels (MCLs)* as part of the *Safe Drinking Water Act (SDWA)*.

Synthetic Seawater — An artificial product of the approximate ionic composition of seawater.

System Design Capacity — (Water Quality) Plant design capacity plus any blending water added to the desalting plant product.

System Head Curve — A curve of system head comprising total static head and head loss in the system versus flow through the system.

System with a Single Service Connection — A system that supplies drinking water to consumers via a single service line.

Systemic — (1) Relating to whole body, rather than its individual parts. (2) Any chemical that is absorbed into a plant's system, either to kill organisms that feed on the plant or to kill the plant itself. There are systemic insecticides, fungicides, and herbicides.

Systemic Effects — Effects observed at sites distant from the entry point of a chemical due to its absorption and distribution into the body.

T

Tacheion — (Ecology) A division of aquatic organisms that includes both crawling and free-swimming forms.

Tacking — The binding of *Mulch* fibers by mixing them with an adhesive chemical compound during land *Restoration* projects.

Tafoni — Natural cavities in rocks formed by weathering.

Tahoe–Prosser Exchange Agreement [California–Nevada] — Also referred to as the “Agreement for Water Exchange Operations of Lake Tahoe and Prosser Creek Reservoir,” this agreement was finalized in June 1959 and designated certain waters in Prosser Reservoir in the Truckee River Basin as “Tahoe Exchange Water.” By this agreement, when waters were to be released from Lake Tahoe for a minimum instream flow (50 cfs winter; 70 cfs summer) and when such releases from Lake Tahoe were not necessary for *Floriston Rates* due to normal flows elsewhere in the river, then an equal amount of water (exchange water) could be stored in Prosser Reservoir and used for releases at other times. Also see *Truckee River Agreement [Nevada and California]*.

Tahoe Regional Planning Agency (TRPA) [Lake Tahoe – California and Nevada] — A bi-state regulatory agency created in July 1968 as part of a provisional California–Nevada Interstate Compact developed by the joint California–Nevada Interstate Compact Commission which was formed in 1995. The TRPA was the first bi-state regional environmental planning agency in the United States. The TRPA was intended to oversee land-use planning and environmental issues within the Lake Tahoe Basin and is dedicated to preserving the beauty of the region. Today, the TRPA leads the cooperative effort within the basin to preserve, restore, and enhance the unique natural and human environment of the region and is a leading partner in a comprehensive program which monitors water quality, air quality, and other threshold standard indicators. The TRPA’s Environmental Thresholds Carrying Capacities (ETCC) programs are designed to address the following thresholds:

- Water Quality
- Air Quality
- Soil Conservation
- Vegetation
- Fisheries
- Wildlife
- Scenic Resources/Community Design
- Recreation
- Noise

The structure of the TRPA consists of a 15-member Governing Board which sets TRPA policy, oversees administration of the agency, approves all amendments to the Lake Tahoe Basin Regional Plan and reviews major project applications. The Governing Board is advised by a 19-member Advisory Planning Commission made up of area planning and natural resource management professionals, and lay persons. The Executive Director directs approximately 50 staff members in the following principal functional areas: (1) Environmental Education; (2) Environmental Improvement Program (EIP) Facilitation; (3) Environmental Compliance Division; (4) Project Review Division; and (5) Long Range Planning Division. Representation on the TRPA’s Governing Board is as follows:

- [1] Governor of California Appointee (California);
- [2] Governor of California Appointee (California);
- [3] California Assembly Speaker Appointee (California);
- [4] California Senate Rules Committee Appointee (California);
- [5] El Dorado County Appointee (California);
- [6] Placer County Appointee (California);
- [7] City of South Lake Tahoe Appointee (California);
- [8] Governor of Nevada Appointee (Nevada);
- [9] Nevada Government Appointee (Nevada);
- [10] Nevada Department of Conservation & Natural Resources Appointee (Nevada);
- [11] Washoe County Appointee (Nevada);
- [12] Douglas County Appointee (Nevada);
- [13] Carson City Appointee (Nevada);
- [14] Nevada at-Large Appointee (Nevada);
- [15] Presidential Appointee (United States)

In late 1995 the TRPA created the Shorezone Partnership Committee of 20 organizations and entities to lessen the problems among those interested in the future development of Lake Tahoe. Those represented included: California and Nevada state lands; California and Nevada state parks, California Department of Fish and Game, California Tahoe Conservancy, Lahontan Regional Water Quality Control Board; League to Save Lake Tahoe; Nevada Division of Wildlife; Tahoe Lakefront Owners Association; TRPA; Tahoe Research Group; Tahoe–Sierra Preservation Council; U.S. Army Corps of Engineers; U.S. Forest Service;

commercial property owners; Lake Tahoe marinas; Lake Tahoe tour-boat operators; other private property owners; and Lake Tahoe Basin recreation concessionaires.

Taiga — A subarctic, evergreen coniferous forest of northern Eurasia located just south of the *Tundra* and dominated by firs and spruces. Also referred to as a *Boreal Forest*. Also see *Biome*.

Tail Water (Tailwater) — (1) In *Hydraulics*, water, in a river or channel, immediately downstream from a structure. (2) The river stage immediately downstream from the dam at a reservoir or a lock and dam. This stage is usually controlled by gates. It is a function of the number of gate openings and the height of the pool behind the dam. (3) In *Irrigation*, water that reaches the lower end of a field; excess surface water draining especially from a field under cultivation. Tail water is not necessarily lost; it can be collected and reused on the same or adjacent fields.

Tailings — The waste material remaining after metal is extracted from ore.

Tailrace — (1) The part of a *Millrace* below the water wheel through which the spent water flows; the channel which conducts water away from a water wheel. (2) A channel for floating away mine tailings and refuse. (3) A race for conveying water away from a point of industrial application (as a waterwheel or turbine) after use.

Tailwater Height — Height of water immediately downstream of the dam (where various datums may be used).

Tailwater Recovery — The process of collecting irrigation water runoff for reuse in the system.

Tailwater Runoff — Refers to unused irrigation water or rain water that is collected at the base or at the end of an irrigation system or field in a ditch or other impoundment. This water may be reused again for irrigation purposes, left to evaporate, percolate into the ground, treated, and/or discharged to surface bodies of water.

“Taking” — A concept covered under the 5th Amendment of the U.S. Constitution which requires compensation for landowners whose property value is reduced by a given regulation. More specifically, the 5th Amendment prohibits the taking of private property for public use “without just compensation.” Generally, the courts have found that compensation is required where an owner is deprived of all or nearly all of the value of his property, balancing a property owner’s justifiable expectations of the use of his property against the rights and interests of the public affected. Because of the economic costs inherent in the implementation of the *Endangered Species Act (ESA)* and the *Clean Water Act (CWA)*, especially, there has been a growing movement to require compensation for landowners whose property values have been adversely affected by the regulatory requirements of these acts.

Talus — The heap of coarse rock waste at the foot of a cliff or a sheet of waste covering a slope below a cliff.

Talweg — See *Thalweg*.

Tank — (1) An artificial pool, pond, reservoir, cistern, or large container for holding and storing water for drinking or irrigation. (2) In peninsular India and Ceylon, small reservoirs, ponds and lakes that have been constructed to impound water during the wet season.

Tap — A valve and spout used to regulate delivery of a fluid at the end of a pipe.

Tapered Aeration — A modification of the activated sludge process wherein air is introduced at a higher rate at the head of the tank than in subsequent sections.

Tap Water — Water withdrawn directly from a tap or faucet.

Taproot — A main root that grows straight down. Taproots can go very deep if there is a lack of soil moisture near the surface.

Tar Balls — Non-volatile hydrocarbon clumps remaining in water after the volatile fractions have evaporated from crude oil that has been discharged or spilled into the marine environment. When washed ashore, these residues, which range in size from marbles to beach balls, spoil beaches and marine habitat.

Tar Sands — Sands or sandstone naturally impregnated with petroleum from which the lighter portions have escaped.

Tarn — A small steep-banked mountain lake or pool, generally formed by a glaciation process. See *Cirque Lake*.

Taxonomic Diversity — (Biodiversity Measure) The number of representatives at each taxonomic level (e.g., genera, family, order, phyla, kingdom). This measure provides an index of genetic diversity.

Taxonomy — (1) The science, laws, or principles of classifying living organisms in specially named categories based on shared characteristics and natural relationships. (2) The division of biology concerned with the classification and naming of organisms. The classification of organisms is based upon a hierarchical scheme beginning with Kingdom and ending with Species at the base. The higher the classification level (i.e., going from kingdom to species), the fewer features the organisms have in common. For example, the taxonomy of the Lahontan cutthroat trout (LCT), *Oncorhynchus clarki henshawi*, is the following:

Taxonomy – Lahontan Cutthroat Trout (LCT) <i>Oncorhynchus clarki henshawi</i>	
Kingdom	Animal
Phylum	Chordata
Class	Osteichthyes
Order	Salmoniformes
Family	Salmonidae
Genus	<i>Oncorhynchus</i>
Species	<i>clarki</i>
Subspecies	<i>henshawi</i>

TCE — See *Trichloroethane*.

TCID — See *Truckee–Carson Irrigation District (TCID) [Nevada]*.

TCR — Total Coliform Rule.

TDH — See *Total Dynamic Head*.

TDS — All of the dissolved solids in water. TDS is measured on a sample of water that has passed through a very fine mesh filter to remove suspended solids. The water passing through the filter is evaporated and the residue represents the dissolved solids. See *Total Dissolved Solids*. Also see *Specific Conductance*.

Technical Impracticability (TI) [EPA] — Refers to a situation where achieving groundwater cleanup levels associated with final cleanup goals is not practicable from an “engineering perspective.” The phrase “engineering perspective” refers to how factors such as feasibility, reliability, scale, and safety influence the ability to achieve groundwater cleanup objectives.

Technology-Based — Describing emission or effluent limitations that are not defined in terms of allowable releases that achieve a desirably low ambient pollutant concentration, but instead are based on the pollutant control efficiency that is achievable using current levels of technology.

Technology-Based Limitations — (EPA) Industry-specific effluent limitations applied to a discharge when it will not cause a violation of water quality standards at low stream flows. Usually applied to discharges into large rivers.

Technology-Based Standards — (EPA) Effluent limitations applicable to direct and indirect sources which are developed on a category-by-category basis using statutory factors, not including water-quality effects.

Technology-Forcing — Describing standards or levels of pollution and effluent control called for in environmental statutes or regulations for which existing technologies are inadequate and therefore require technical advancements to achieve.

Tectonic — Pertaining to rock structures and topographic features resulting from deformation of the Earth’s crust.

Tectonics — (Geology) A branch of geology that is concerned with the study of the features, deformational movements, and processes of the Earth’s crust, including their mutual relationships, origins, and historical development. See *Plate Tectonics*. Also referred to as *Geotectonics*.

Teleconnection — (Meteorology) A term which describes the influence of an aberration in weather patterns in one part of the world to cause strange weather in another area of the globe. Also see *El Niño*, *El Niño/Southern Oscillation (ENSO)*, and *Hurricane Forecasting*.

Telmatology — (Ecology) The science or study of *Wetland* and *Swamp* habitats.

Telmicolous — (Ecology) Living or thriving in freshwater marshes. Derivative term includes *Telmicole*.

Temperate (Deciduous) Forest — Forested areas characterized by moderate temperatures, weather, or climate, and rainfall from 30 to 60 inches per year. These forests are found in eastern North America, eastern Australia, western, central, and eastern Europe, and parts of China and Japan. Typical deciduous trees in the North American deciduous forests are oak, hickory, maple, ash, and beech. Also see *Biome*.

Temperate Glacier — A temperate-zone *Glacier* composed of ice and *Firn* near the melting point at the end of the ablation season.

Temperature — The degree of hotness or coldness. Also, a measure of the average energy of the molecular motion in a body or substance at a certain point.

Temperature Gradient — The rate of change of temperature with increase in height or decrease in depth.

Temperature-Humidity Index — (Meteorology) A measure of the combined effects of temperature and moisture on humans during a warm season. The index is computed by multiplying the sum of the dry-bulb and wet-bulb Fahrenheit temperature readings by 0.4 and adding 15 to that figure. Also referred to as a *Comfort Index* or *Discomfort Index*.

Temperature Inversion — (1) (Oceanography) Any anomalous condition in a body of water that causes the temperature of a water layer to increase with depth. (2) (Meteorology) A surface cooling at the Earth’s surface which sometimes leads to an increase in temperature with altitude.

Temperature Regulation — The processes through which an organism’s temperature is adjusted to certain metabolic requirements or conditions in its environment. For example, the act of human perspiration promotes surface skin evaporation which cools the body.

Temperature Scale — The temperature scale adopted by a 1960 international conference was based on a fixed temperature point, the *Triple Point* of water, at which the solid, liquid, and gas are in equilibrium. The temperature of 273.16 K (Kelvin) was assigned to this point. The freezing point of water was designated as 273.15 K, equaling exactly 0° on the *Celsius Temperature Scale*. The Celsius scale, which is identical to the *Centigrade Temperature Scale*, is named for the 18th-century Swedish astronomer Anders Celsius, who first proposed the use of a scale in which the interval between the freezing and boiling points of water is divided into 100 degrees. By international agreement, the term Celsius has officially replaced Centigrade.

Tempest — A violent windstorm, frequently accompanied by rain, snow, or hail.

Temporary Groundwater Table — (1) During and for a period following heavy rainfall or snow melt, the soil is saturated at elevations above the normal, stabilized or seasonal groundwater table, often from the surface of the soil downward. This is referred to as a temporary condition and thus is a temporary groundwater table. (2) When a collection system serves agricultural areas in its vicinity, irrigation of these areas can cause a temporary rise in the elevation of the groundwater table.

Temporary Hardness — Water hardness that can be reduced or removed by heating the water. Heating drives off carbon dioxide, shifting the carbonate buffer system equilibrium so that carbonate ions combine with dissolved calcium or magnesium ions, form solids, and precipitate. This lowers the calcium/magnesium ion water concentration, lowering the hardness. Also referred to as *Carbonate Hardness*. Also see *Ion Exchange*.

Temporary Permit — A temporary authorization issued by the State engineer for the use of public water for construction, testing or drilling purposes without any grant of water rights.

Temporary Transfer — The transfer of a water right from one purpose to another for a specifically designated period of time.

Temporary Use Permit — Before development of part or all of the water appropriated under a future use permit or permit, a temporary appropriation of the water may be made.

Temporary Wetland — A type of *Wetland* in which water is present for only part of the year, usually during the wet or rainy seasons (e.g., spring). Also referred to as *Vernal Pools*.

Tenaja — Pools in seasonal streams that may support a flora similar to *Vernal Pools* upon desiccation.

Tensiometer — An instrument used for measuring the suction or negative pressure of soil water.

Tennessee Valley Authority (TVA) — A Depression-era federal government project created in 1933 to control and harness the Tennessee River and its tributaries. The TVA became perhaps the best known of President Franklin Roosevelt's "New Deal" public works projects. The TVA currently operates 47 dams, 11 coal-fired and 2 nuclear power plants, and an extensive power transmission system. The Tennessee Valley Authority Power System encompasses the state of Tennessee and parts of the states of Kentucky, Virginia, North Carolina, Georgia, Alabama, and Mississippi, and borders the Mississippi River on the west.

Tephra — (Geology) Volcanic material; ash-fall.

Teratogenic — Causing birth defects.

Terminal Lake — A lake with no outlet.

Terminal Moraine — Constitutes the material (*Glacial Till*) left behind by the farthest advance of a Glacier's toe. Each different period of glaciation leaves behind its own uniquely developed moraines. Also see *Moraines*, *Lateral Moraines*, and *Recession Moraine*.

Terminal Spill — Refers to those releases made at the terminal ends of the project conveyance or reservoir system. These canal or reservoir releases are not reused on the project's improved irrigated acreage. Also see *Operational Spill*.

Terminal Velocity — The final velocity of falling solid particles in water or in air or of raindrops in air.

Terminal (Settling) Velocity — For a particle falling in a nonturbulent fluid (liquid or gas), the maximum possible velocity reached when the drag, or frictional resistance, on the particle equals the gravitational force on the particle. The measure is used in the design of chambers in which particles are removed from air or from water by gravitational settling. The horizontal flow rate through the chamber must allow time for the particles to reach the bottom of the *Settling Chamber*.

Terminus — Refers to the location of water's final destination, as in the terminus of a river system being a *Terminal Lake*.

Terrace — (1) (Erosion and Irrigation) A broad channel, bench, or embankment constructed across the slope to intercept runoff and detain or channel it to protected outlets, thereby reducing erosion from agricultural areas. (2) An embankment or combination of an embankment and channel constructed across a slope to control erosion by diverting and temporarily storing surface runoff instead of permitting it to flow uninterrupted down the slope. Outlets may be soil infiltration only, vegetated waterways, tile outlets, or combinations thereof. (3) (Geological) An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide. (4) Also, a *Berm* or discontinuous segments of a berm, in a valley at some height above the *Flood Plain*, representing a former abandoned flood plain of the stream.

Terraces — See *Wave-Cut Terraces*.

Terracing — A series of levels on a hillside, one above the other; dikes built along the contour of sloping farm land that hold runoff and sediment to reduce erosion. Hillside farming on terraces greatly reduces water erosion of soil.

Terraqueous — Composed of land and water.

Terrestrial — Living or growing on land rather than in water or air.

Terrestrial Frozen Water — Water on the surface of the earth that is either seasonally or perennially frozen.

Terrestrial — Derived from or originating on the land (usually referring to sediments) as opposed to material or sediments produced in the ocean (marine) or as a result of biologic activity (biogenous).

Territorial Waters — (Legal) (1) The waters under the sovereign jurisdiction of a nation or state including both marginal sea and inland waters. (2) In international law, waters subject to the jurisdiction of a sovereign nation, as distinguished from *High Seas*, and consisting of waters within the nation, waters that are boundaries between nations, and coastal waters. Such jurisdiction extends also to the air space above and to the bed beneath those waters. Jurisdiction over boundary waters, such as lakes or rivers, is fixed by treaties; the limit of the jurisdiction of each nation is usually an imaginary line drawn through the center of such waters. In the United States each state exercises jurisdiction over waters wholly within the state, but streams forming part of the system of interstate waterways are subject to federal government control. Also see *Interstate Compact*.

Tertiary Treatment — (Wastewater Treatment) (1) The treatment of wastewater beyond the secondary or biological stage. Normally implies the removal of nutrients, such as phosphorous and nitrogen, and a high percentage of suspended solids. (2) Any process of water renovation that upgrades treated wastewater to meet specific reuse requirements. May include general cleanup of water or removal of specific parts of wastes insufficiently removed by conventional treatment processes. Typical processes include chemical treatment and pressure filtration. Also called *Advanced Waste Treatment*. Also see *Tertiary Wastewater Treatment*.

Tertiary Wastewater Treatment — (Wastewater Treatment) Selected biological, physical, and chemical separation processes to remove organic and inorganic substances that resist conventional treatment practices; the additional treatment of effluent beyond that of primary and secondary treatment methods to obtain a very high quality of effluent. The complete wastewater treatment process typically involves a three-phase process: (1) First, in the *Primary Wastewater Treatment* process, which incorporates physical aspects, untreated water is passed through a series of screens to remove solid wastes; (2) Second, in the *Secondary Wastewater Treatment* process, typically involving biological and chemical processes, screened wastewater is then passed a series of holding and aeration tanks and ponds; and (3) Third, the *Tertiary Wastewater Treatment* process consists of flocculation basins, clarifiers, filters, and chlorine basins or ozone or ultraviolet radiation processes. Tertiary techniques may also involve the application of wastewater to land to allow the growth of plants to remove plant nutrients.

Test Hole (Test-Well) — (Hydraulics) (1) A well hole drilled for experimental or exploratory purposes. (2) A hole designed to obtain information on groundwater quality or geological and hydrological conditions, or both.

Test Well — A well constructed for aquifer testing.

(Local) Test-Well Site Designation [Nevada] — The local test-well site designation used in Nevada is based on the identification of a site by hydrographic area and by the official rectangular subdivision of the public lands referenced to the Mount Diablo (located east of Walnut Creek, California) base line and meridian and is based on the *Public Land Survey System (PLSS)*. Each site designation consists of four units: The first unit is the hydrographic area number. The second unit is the township, preceded by an N or S to indicate location north or south of the base line. The third unit is the range, preceded by an E to indicate location east of meridian. The fourth unit consists of the section number and letters designating the quarter section, quarter-quarter section, and so on (A, B, C, and D indicate the northeast, northwest, southwest, and southeast quarters, respectively), followed by a number indicating the sequence in which the site was recorded. For example, site 210 S12 E63 29DABC2 is in Coyote Spring Valley (Nevada Hydrographic Area 210). It is the second site recorded in the southwest quarter (C) of the northwest quarter (B) of the northeast quarter (A) of the southeast quarter (D) of Section 29, Township 12 South, Range 63 East, Mount Diablo base line and meridian.

Test-Well Site Identification (U.S. Geological Survey) — The standard *U.S. Geological Survey (USGS)* site identification is based on the grid system of latitude and longitude. The number consists of 15 digits. The first six digits denote the degrees, minutes, and seconds of latitude; the next seven digits denote degrees, minutes, and seconds of longitude; and the last two digits (assigned sequentially) identify the sites within a 1-second grid. For example, site 365227114554401 is at 36E52N270 latitude and 114E55W440 longitude, and it is the first site recorded in that 1-second grid. The assigned number is retained as a permanent identifier even if a more precise latitude and longitude are later determined. Also see *(Local) Test-Well Site Designation [Nevada]*.

Tetrachloroethylene (Perchloroethylene, PCE) — A solvent often used for degreasing and in dry cleaning which sometimes makes its way into water wells and other groundwater supplies. Studies have shown that high concentrations of the chemical can cause liver and kidney damage, including cancer, in animals. In humans, however, not enough information is available to say it is a definite carcinogen. The *U.S. Environmental Protection Agency's (EPA)* safe drinking water standard for tetrachloroethylene is 0.005 parts per million (ppm). Also referred to as *Perchloroethylene (PCE)* and *Perclene*.

Texture — (1) Refers to relative proportions of clay, silt, and sand in soil. (2) The physical appearance of a rock, as shown by size, shape, and arrangement of the particles in the rock.

Thalassic — (Oceanography) (1) Of or relating to inland seas or minor seas, such as the Aegean. (2) Of or relating to the deposition of fine-grained sediments in relatively deep, still water far from land.

Thalassography — (Oceanography) The study of smaller bodies of water, such as bays, sounds, and gulfs.

Thalassostatic — Relating to a lower portion of a river that is subject to tidal influences.

Thalweg — (1) The line connecting the deepest points along a stream. A line joining the lowest points along the entire length of a streambed or valley, whether or not the bed or valley lies underwater. Also referred to as a *Valley Line*. (2) The lowest thread along the axial part of a valley or stream channel. (3) A subsurface, ground-water stream percolating beneath and in the general direction of a surface stream course or valley. (4) The middle, chief, or deepest part of a navigable channel or waterway. (5) The line of maximum depth in a stream. The thalweg is the part that has the maximum velocity and causes cutbanks and channel migration. (6) (Geology) A line representing the profile of a land surface that crosses all contour lines at right angles. (7) (Geography) The midpoint in the navigable channel of a waterway serving as a boundary between states. Also referred to as *Talweg*.

Thank-You-Ma'am — (Derived from its causing a nodding of the head) A bump or depression in a road; especially a ridge or hollow made across a road on a hillside to cause water to run off and thereby minimize erosion. Also known as a *Water Break*.

Thatch — Dead stems that build up beneath certain ground covers and lawn grasses, sometimes becoming so thick and compressed as to impede infiltration by water.

Thaw — (1) To change from a frozen solid to a liquid by gradual warming. Synonymous with *Melt*. (2) To become warm enough for snow and ice to melt. (3) A period of warm weather during which ice and snow melt.

The Nature Conservancy — See *(The) Nature Conservancy (TNC)*.

Theoretical Oxygen Demand (ThOD) — The amount of oxygen that theoretically is required to totally oxidize a substance.

Thermal — Having to do with heat, as a hot spring (*Thermal Spring*).

Thermal Gradient — A temperature difference between two areas.

Thermal Mass — Materials that absorb heat or coolness and store it for a long period of time. Water and masonry materials can provide thermal mass. Such materials react slowly to temperature variations and are important aspects of any passive heating or cooling system.

Thermal Plant — A power generating plant which uses heat to produce energy. Such plants may burn fossil fuels or use nuclear energy to produce the necessary thermal energy.

Thermal Plume — The hot water discharged from a power generating facility or other industrial plant. When the water at elevated temperature enters a receiving stream or body of water, it is not immediately dispersed and mixed with the cooler waters. The warmer water moves as a single mass (plume) downstream from the discharge point until it cools and gradually mixes with that of the receiving stream. Also see *Thermal Pollution*.

Thermal Pollution — (1) The influx of heated water, usually from a power plant, wastewater from a factory or sewage treatment plant, or the discharge of other industrial cooling water, into a stream, lake, bay, or ocean, disturbing the temperature of the given body of water. The resulting shift to a warmer aquatic environment can cause a change in species composition and lower the dissolved oxygen content of the water. Also has application to air, through waste heat emitted by industry, home appliances,

machines, etc. (2) (Ecology) Any increase in the temperature of a body of water that is caused by human activity (e.g., a discharge of heated water from a power plant or of heated industrial waste) and that has a harmful effect on water quality or on water-dwelling life.

Thermal Spring — (1) A spring whose water temperature is greater than the average annual atmospheric temperature in the vicinity of the spring. (2) A spring that brings warm or hot water to the surface. Sometimes called *Warm Spring*, or *Hot Spring* depending on the relative water temperatures. Temperature usually 15EF (9.4EC) or more above mean air temperatures.

Thermal Stratification — (1) The formation of layers of different temperatures in a lake or reservoir. Specifically, the division of a lake or other body of water into horizontal layers of differing densities, as a result of variations in temperature at different depths. Also see *Stratification*. (2) The vertical temperature stratification of a lake or reservoir which consists of: (a) the upper layer, or *Epilimnion*, in which the water temperature is virtually uniform; (b) the middle layer, or *Thermocline*, in which there is a marked drop in temperature per unit of depth; and (c) the lowest stratum, or *Hypolimnion*, in which the temperature is again nearly uniform.

Thermally Stratified Lake — See *Thermal Stratification*.

Thermocline — (1) The middle layer in a thermally stratified lake or reservoir. In this layer there is a rapid decrease in temperature with depth. Also called the *Metalimnion*. (2) The region in a thermally stratified body of water which separates warmer oxygen-rich surface water from cold oxygen-poor deep water and in which temperature decreases rapidly with depth. (3) A layer in a large body of water, such as a lake, that sharply separates regions differing in temperature, so that the temperature gradient across the layer is abrupt. (4) The intermediate summer or transition zone in lakes between the overlying *Epilimnion* and the underlying *Hypolimnion*, defined as that middle region of a thermally stratified lake or reservoir in which there is a rapid decrease in temperature with water depth. Typically, the temperature decrease reaches 1EC or more for each meter of descent (or equivalent to 0.55EF per foot).

Thermoelectric Power — Electrical power generated using fossil-fuel (coal, oil, or natural gas), geothermal, or nuclear energy.

Thermoelectric Power Water Use — Water used in the process of the generation of *Thermoelectric Power*. The water may be obtained from a Public Water Supply System or may be self supplied. Also see *Self-Supplied Water*.

Thermoerosion — Refers to erosion by water combined with its thermal effect on frozen ground. Small channels can develop into gullies up to several kilometers in length, growing at rates of 10-20 meters per year, and in sandy deposits, as fast as 1 meter per hour. The main climatic factors controlling the intensity of thermoerosion are snow melt regime and summer precipitation.

Thermograph — A self-registering thermometer which has a thermometric element consisting either of a bimetallic strip or a metal tube filled with alcohol or mercury, and makes an autographic record on a ruled chart wrapped around a clock-driven cylinder.

Thermohaline — (Oceanography) Of or relating to the joint action of temperature and salinity in a water mass.

Thermohaline Convection — (Oceanography) The vertical movement of a layer of water caused by changes in the temperature-salinity relationship between it and the adjoining layers, usually because one layer has become colder or more saline, or both, and thus become heavier.

Thermokarst — Refers to a range of features formed in areas of low relief when *Permafrost* with excess ice thaws. These are unevenly distributed and include hummocks and mounds, water-filled depressions, “drunken” forests, mud flows on sloping ground, new fens, and other forms of thaw settlement that account for many of the geotechnical and engineering problems encountered in periglacial landscapes. Even where repeated ground freezing takes place, thermokarst features, once formed, are likely to persist.

Thermoplastic Casing — Water well casing made from acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene rubber (SR).

Thickener — A *Settling Pond* or tank where the concentration of solids is increased by allowing settling and the removal of clarified liquid. The solids that are pumped from the bottom of the pond or tank are much thicker than the incoming fluid.

Thiokol — A trademark used for any of various polysulfide polymers in the form of liquids, water dispersions, and rubbers used in seals and sealants.

Third Party (Parties) — The people, communities, and environments not directly engaged in a transfer of water or water rights (i.e., the buyers or sellers) but still affected by the transfer. These affected parties can include areas of origin, Indian tribes, other minority cultures and peoples, communities that depend on irrigated agriculture or water-based recreation, boaters, anglers, and broad segments of the public who care about wetlands, riparian areas, endangered species, instream (minimum) flows, aesthetics, and other environmental values that might be harmed or enhanced by a change in water use.

Third-Party Impacts — Direct and indirect economic, social or environmental effects of a water transfer to a party other than the seller or buyer.

THM — See *Trihalomethanes*.

Thread — (1) A thin stream of water. (2) The middle of a stream of water.

Threatened Species — (Ecology) (1) A species of animal or plant that has been identified as facing a possible threat of extinction, due to a gradual reduction in its overall population or significant changes in its environment. Threatened species are felt to not face as great a threat as an *Endangered Species*. (2) Any plant or animal species likely to become an “endangered” species within the foreseeable future throughout all of a significant area of its range or natural habitat; identified by the Secretary of the Interior as “threatened”, in accordance with the 1973 *Endangered Species Act (ESA)*.

Threats to Water Quality — See *Water Quality Threats*.

Three-Mile Limit — The limit of the marginal sea of three miles included in the territorial waters of a state.

Threshold — The lowest dose of a chemical at which a specified measurable effect is observed and below which it is not observed.

Threshold Odor — The minimum odor of a water sample that can just be detected after successive dilutions with odorless water. Also called *Odor Threshold*.

- Threshold Odor Number (TON)** — (1) The greatest dilution of a sample with odor-free water that still yields a just-detectable odor. (2) A value indicative of the maximum dilution which can be made of a sample with its odor remaining detectable. A higher *TON* indicates a stronger odor.
- Threshold Pollutant** — A substance that is harmful to a particular organism only above a certain concentration, or threshold level.
- Threshold Runoff** — The runoff in inches from a rain of specified duration that causes a small stream to slightly exceed bankfull. When available, flood stage is used instead of slightly over bankfull.
- Through Glacier** — A glacier having two ends, formed by two valley glaciers that flow outward in opposite directions from the same depression.
- Throughfall** — In a vegetated area, the precipitation that falls directly to the ground, or the rainwater or snowmelt that drops from twigs or leaves.
- Thunder** — The crashing or booming sound produced by rapidly expanding air along the path of the electrical discharge of lightning.
- Thunderbird** — (Mythology) A spirit of thunder, lightning, and rain in the form of a huge bird in the mythology of certain Native American peoples.
- Thundercloud** — A large dark cloud charged with electricity and producing thunder and lightning; A *Cumulonimbus* cloud. See *Cloud*.
- Thunderhead** — A round mass of *Cumulus Clouds* appearing before a *Thunderstorm*.
- Thundershower** — A shower accompanied by thunder and lightning.
- Thundersquall** — A squall accompanied by thunder and lightning.
- Thunderstorm** — A storm accompanied by thunder and lightning.
- Thrust Block** — A mass of concrete or similar material appropriately placed around a pipe to prevent movement when the pipe is carrying water. Usually placed at bends and valve structures.
- Tidal** — (1) (Oceanography) Of or relating to *Tides*. (2) (Geography) Describing low-lying land along a coast that is usually flooded at high tide, such as a *Tidal Flat* or *Tidal Marsh*.
- Tidal Basin** — (Oceanography) A natural or artificial body of water that is subject to tidal action, or that is open to another body of water, for example a river subject to tidal action.
- Tidal Creek** — A tidal inlet or estuary of a small river or brook.
- Tidal Day** — (Oceanography) The interval between two successive upper transits of the moon over a local meridian, averaging 24.84 hours. Also referred to as *Lunar Day*.
- Tidal Delta** — A delta at the mouth of an inlet, formed by changing tides that move sand in and out of the inlet.
- Tidal Energy** — The mechanical energy associated with the rising and falling of water level during the movement of the tides. Also see *Tidal Power*.
- Tidal Flat** — (1) An extensive flat tract of land alternatively covered and uncovered by the tide, and comprising mostly unconsolidated mud and sand. (2) A broad, marshy or barren area of unconsolidated sediment forming a coastal flatland that is alternately covered and uncovered according to the level of the tides. (3) Saltwater wetlands that are characterized by mud and/or sand. Tidal flats often occur at the seaward edges of salt marshes. They're covered with seawater during high tide and become exposed during low tide. Algae are the dominant plants in tidal flats. Also referred to as *Tide Flat*.
- Tidal Fringe Wetlands** — Most typically the term applies only to vegetated habitats occupying the intertidal zone of marine, estuarine, or riverine systems. Specifically, these wetlands occur along the fringe of drowned river valleys, barrier islands, lagoons, fjords, and other coastal waterways; receive their water primarily from marine or estuarine sources; and are affected by astronomical (gravitational) tidal action. Included in this group are wetlands commonly known as intertidal marshes, salt marshes, forested riverine swamps, and mangrove swamps and correspond to the emergent, scrub-shrub, and forested wetland class designations. The dominant hydrodynamic characteristic of tidal fringe wetlands is bidirectional (ebb and flow) water flow generated by tidal action. Additional water sources may be riverine flow, groundwater discharge, and precipitation. Tidal fringe wetlands lose water by tidal exchange, by saturated overland flow to tidal creek channels, and by *Evapotranspiration*. Organic matter normally accumulates in higher elevation marsh areas where flooding is less frequent and the wetlands are isolated from shoreline wave erosion by intervening areas of low marsh. Salt marshes are a common example of tidal fringe wetlands. A number of relatively unique benefits are afforded by tidal fringe wetlands. For example, *Hydrogeomorphic* functions associated with these wetlands include:
- [1] **Tidal Surge Attenuation** – The capacity of a wetland to reduce the amplitude of tidal storm surges;
 - [2] **Tidal Nutrient and Organic Carbon Exchange** – The ability of a wetland to import and export nutrients and organic carbon (dissolved and particulate); and
 - [3] **Sediment Deposition** – Deposition and retention of inorganic and organic particulate from the water column, primarily through physical processes.
- In addition, the habitat functions associated with tidal fringe wetlands include:
- [4] **Maintenance of Characteristic Plant Community Composition and Structure** – The ability of a wetland to support a native plant community of characteristic species composition and structure;
 - [5] **Resident Nekton Utilization** – Describes potential utilization of the wetland by resident fishes and macrocrustaceans;
 - [6] **Nonresident Nekton Utilization** – Describes potential utilization of the wetland by nonresident (transient) fishes and macrocrustaceans;
 - [7] **Nekton Prey Pool** – Describes the potential for the wetland to produce and maintain a characteristic benthic and epiphytic invertebrate prey pool; and
 - [8] **Wildlife Habitat Utilization** – Describes potential utilization of the wetland by resident and migratory avifauna,

reptiles, amphibians, and mammals.

Tidal Glacier — See *Tidewater Glacier*.

Tidal Inlet — A waterway from open water into a lagoon through which water flows landward with the rising tide and seaward with the falling tide. Similarly, *Tidal Outlet*.

Tidal Marsh — (1) A low elevation marshy coastal area formed of mud and the root mat of *Halophytic* plants, regularly inundated during high tide. (2) Low, flat marshlands traversed by interlaced channels and tidal sloughs and subject to tidal inundation. Typically, the only vegetation present is salt-tolerant bushes and grasses (*Halophytes*).

Tidal Outlet — See *Tidal Inlet*.

Tidal Pool — See *Tidepool*.

Tidal Power — A form of power obtained from the filling and emptying of a *Bay* or an *Estuary* that can be closed by a dam. The enclosed basin is allowed to fill and empty only during brief periods at high and low tides in order to develop as much power as possible.

Tidal Scour — (Geology) The erosion of the ocean floor by powerful tidal currents, causing the removal of inshore sediments and the development of various-sized depressions in the sea floor.

Tidal Surge Attenuation (TSA) — The capacity of an *Estuary* or *Tidal Fringe Wetland* to reduce the amplitude of tidal storm surges. A quantitative measure of this function would be expressed at the percent reduction in wave energy (or height) per unit distance across the marsh, tidal fringe wetland, or estuary surface. The ability of a wetland to attenuate storm surges depends on several factors, including the degree of surface roughness attributed to vegetative extent, surface obstructions and/or microtopography, and the distance over which storm surges may travel across the wetland. Vegetated intertidal wetlands provide enhanced protection against the destructive effects of wave energy associated with storm surges. Vegetation characteristics and the distance across which a storm surge must travel are key factors in the ability of a tidal fringe wetland to mediate the effects of tidal storm surges.

Tidal Volume — The volume of water entering and leaving a bay or salt marsh as the water level fluctuates because of the tides.

Tidal Waters [United States, 33 CFR 328.3(f)] — The term “tidal waters” means those waters that rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by hydrologic, wind, or other effects.

Tidal Wave — (Oceanography) (1) The wave motion of a tide. (2) An unusual rise or incursion of water along the seashore, as from a storm or a combination of wind and spring tide. (3) Commonly, an unusually high and destructive ocean wave such as a *Tsunami* or *Storm Surge*. A huge sea wave caused by a great disturbance under an ocean, as a strong earthquake or volcanic eruption. (4) An overwhelming manifestation; a flood. Also referred to as *Tide Wave*.

Tidal Wetland — A tidal wetland is a *Wetland* (i.e., a water of the United States) that is inundated by tidal waters. The definitions of a *Wetland* and *Tidal Waters* can be found at 33 Code of Federal Regulations (CFR) 328.3(b) and 33 CFR 328.3(f), respectively. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pull of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tide line (i.e., spring high tide line) and are inundated by tidal waters two times per lunar month, during spring high tides.

Tide Cycle — The duration of a given tidal sequence, as for example, a lunar month or a tidal day.

Tide Gate — (1) A swinging gate on the outside of a drainage conduit from a diked field that excludes water at high tide and permits drainage at low tide. (2) A gate with a flap suspended from a free swinging horizontal hinge, usually placed at the end of a conduit discharging into a body of water having a fluctuating surface elevation. The gate is usually closed because of outside water pressure, but will open when the water head inside the pipe is great enough to overcome the outside pressure, the weight of the flap, and the friction of the hinge. Also called a *Backwater Gate*. Also see *Check Valve* and *Flap Gate*.

Tide Race — (Oceanography) (1) A very rapid tidal current. (2) The narrow channel or passage through which such a current flows.

Tideland — (1) Land overflowed during flood tide. (2) Land underlying the ocean and lying beyond the low-water limit of the tide but being within the territorial waters of a nation. Often used in the plural.

Tideland (or Tidal) Flooding — The periodic flooding of *Tidelands* during extremely high tides coupled with strong winds and/or high river stages flowing out over a high tide.

Tideline — (Ecology) The area of a coastline that is intermittently submerged as a result of the regular rise and fall of the water level.

Tidemark — A line or an artificial indicator marking the high-water or low-water limit of the tides.

Tidepool (or Tide Pool) — (1) (Oceanography) (1) A pool of seawater that remains in a depression on a beach or reef after the tide has receded. (2) (Ecology) Specifically, a pool that is regularly submerged at high tide and exposed at low tide that creates a habitat of a wide variety of organisms in the rocky intertidal zone that retains some water at low tide. (3) (Biological) A pool of water formed in the *Intertidal Zone* between the continent and the ocean. Biologically, tide pools perhaps best epitomize the “edge effect” in that the wildlife communities of such areas tend to become richer along the border of two different habitats, i.e., marine aquatic and seashore terrestrial. This is a consequence of the fact that this “border” zone supports flora and fauna from both areas, plus a wide variety of species especially adapted to the transition zone between them. The actual seam, also referred to as the intertidal zone, is neither quite land nor quite sea, but both, being perpetually covered and uncovered by the tides. The tidepool itself reflects the deeper recesses within this marine transition zone where wildlife tends to congregate during low tide periods, in particular. In its broadest sense, this zone is linked with some of the most biologically productive areas known, including river deltas, estuaries, and coastal marshlands. Tidepool areas fuel marine food chains with nutrients, serve as nurseries for a broad array of ocean fauna, and play essential roles in the life cycle of up to three-quarters of all commercially valuable fish and shellfish. Unfortunately, these same areas are among the most threatened of marine environments due to their proximity

to human intervention and development. Also referred to as *Tidal Pool*.

Tides — The alternate rising and falling of the surface of oceans, and of seas, gulfs, bays, rivers, and other water bodies caused by the gravitational attraction of the moon and sun occurring unequally on different parts of the earth. The tide ebbs (falls) and flows (rises) twice in each lunar day (24 hours and 51 minutes). It is occasioned by the attraction of the sun and the moon (the tide-raising force of the latter being three times that of the former), acting unequally on the waters in different parts of the earth, thus disturbing their equilibrium. High tide upon one side of the earth (*Direct Tide*) is accompanied by high tide upon the other side (*Opposite Tide*). Therefore, when the sun and the moon are in conjunction or opposition, as at the new moon and the full moon, their combined action produces a tide greater than usual, called *Spring Tide*. When the moon is at first or third quarter, the sun's attraction in part counteracts the moon's, causing a smaller high tide than usual (and a higher low tide), called *Neap Tide*. The flow or rising of the water is called *Flood Tide*; the reflux, *Ebb Tide*.

Tidewater — (Oceanography) (1) Water that inundates land at flood tide. Water overlying tidelands. (2) Water affected by the tides, especially tidal streams. (3) Low coastal land drained by tidal streams. (Geography) (4) Coastal lowlands, often cut by rivers and inlets. Also referred to as *Tideland*. (5) In specific reference to a geographic area called the Tidewater, which consists of the coastal lowlands of eastern Virginia and North Carolina.

Tidewater Glacier — A glacier that terminates in the ocean, usually forming a vertical wall of ice from which icebergs break off. Also referred to as a *Tidal Glacier*.

Tile Drainage — Land drainage by means of a series of tile lines laid at a specific depth and grade.

Till (Glacial) — (1) Unstratified glacial drift deposited directly by the ice, consisting of mostly clay as matrix, sand, gravel, and boulders. (2) Predominantly unsorted and unstratified drift, generally unconsolidated, deposited directly by and underneath a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, and boulders ranging widely in size and shape. (3) A mixture of rocks, boulders, and soil picked up by a moving *Glacier* and carried along the path of the ice advance. The glacier deposits this till along its path — on the sides of the ice sheet, at the toe of the glacier when it recedes, and across valley floors when the ice sheet melts. These till deposits are akin to the footprint of a glacier and are used to track the movement of glaciers. These till deposits can be good sources of groundwater, if they do not contain significant amounts of impermeable clays. Also see *Moraines*, *Lateral Moraines*, and *Terminal Moraines*.

Tillage — Plowing, seedbed preparation, and cultivation practices.

Tilth — (1) The general physical condition of soil as it relates to agriculture use. (2) Land used for agriculture, as opposed to pasture or forest.

Tilting Gate — (Hydraulics) A hinged gate counterbalanced by weights, that automatically opens and closes with a change in head.

Time-Domain Electromagnetics (TDEM) — (Geophysics) A high technology form of *Dowsing* (*Dousing*), or groundwater exploration, used to search for underground bodies of water (aquifers). The technique employs a grid pattern of electric wires placed on the surface of the ground. The wires are charged with a rapidly pulsating electric current and then the resultant electronic "echoes" are carefully analyzed. These data are then used to construct a three-dimensional computer model of the water-bearing potential of underground rock formations and sediment layers.

Time of Concentration — The time required for water to flow from the farthest point on the water shed to the gaging station, culvert, or other point of interest.

Time of Travel (TOT) — The time required for a contaminant to move in the *Saturated Zone* from a specific point to a well.

Time-Series Analysis — (Statistics) Techniques that attempt to predict the future by using historical data rather than by building cause-and-effect models. Typically, such techniques are most appropriate when the historical data is relatively well behaved and when forecasts, primarily, are sought and not precise cause-and-effect relationships. Contrast with *Cross-Sectional Analysis*.

Time-Weighted Average — (1) The average value of a parameter (e.g., concentration of a chemical in air or water) that varies over time. (2) Computed by multiplying the number of days in the sampling period by the concentrations of individual constituents for the corresponding period and dividing the sum of the products by the total number of days. A time-weighted average represents the composition of water that would be contained in a vessel or reservoir that had received equal quantities of water from the stream each day for the year.

Tipping-Bucket Rain Gage — (Meteorology) A precipitation gage where collected water is funneled into a two compartment bucket; 0.01, 0.1 mm, or some other designed quantity of rain will fill one compartment and overbalance the bucket so that it tips, emptying into a reservoir and moving the second compartment into place beneath the funnel. As the bucket is tipped, it actuates an electric circuit.

Title — The right of property, also the legal evidence of one's right of property.

Titrant — A solution of known strength or concentration; used in *Titration*.

Titrate — To titrate a sample, a chemical solution of known strength is added on a drop-by-drop basis until a certain color change, precipitate, or pH change in the sample is observed (end point). Titration is the process of adding the chemical reagent in increments until completion of the reaction, as signaled by the end point.

Titration — (Chemistry) (1) A method, or the process, of determining the strength of a solution, or the concentration of a substance in solution, in terms of the smallest amount of it required to bring about a given effect in reaction with another known solution or substance, as in the neutralization of an acid by a base. (2) A process whereby a solution of known strength (the *Titrant*) is added to a certain volume of treated sample containing an indicator. A color change shows when the reaction is complete (the end point).

Titration — An instrument, usually a calibrated cylinder (tube-form), used in *Titration* to measure the amount of *Titration* being added to the sample.

TNC — Transient Non-Community (water system).

TNCWS — See *Transient Non-Community Water System*.

Toe — (1) The downstream edge at the base of a dam. (2) The break in slope at the foot of a stream bank where the bank meets the bed. (3) The line of a natural or fill slope where it intersects the natural ground. (4) The lowest edge of a backslope of a cut where it intersects the roadbed or bench.

Toe Drain and Outfall — A drainage conduit from a dam's structure used to carry seepage water away from the dam and can allow seepage quantities to be measured.

Toe of Dam (Upstream and Downstream) — The junction of the face of a dam with the ground surface.

Toe Wall — The downstream wall of a structure.

Toeslope — The lowermost portion of the footslope component of an erosional slope. It is distinguished from the upper footslope by a greater accumulation of pedisement. Also, the lowermost, most gently sloping portion of any slope.

Toilet — A room, shelter, or similar device used for defecation or urination equipped with a bowl-shaped fixture for this purpose fitted with a device for flushing with water.

Toilet Water — A scented liquid with a high alcohol content used in bathing or applied as a skin freshener.

Tongue — (1) In a river, the smooth "V" of fast water found at the head of rapids. (Oceanography) (2) A projection of an ice edge, sometimes several kilometers long. (3) A protrusion of a water mass into a different water mass, especially one of different temperature. See *Ice Tongue*. (4) (Geology) A long, low-lying, narrow strip of land extending out from the mainland into a body of water.

Tonnage — The number of tons of water that a ship displaces when afloat.

Tons per Acre-Foot — The dry mass of dissolved solids in 1 acre-foot of water. It is computed by multiplying the concentration of the constituent, in milligrams per liter (mg/L), by 0.00136.

Tons per Day — The rate representing a mass of 1 ton of a constituent in streamflow passing a cross section in 1 day. It is equivalent to 2,000 pounds per day, or 0.9072 metric tons per day.

Too Numerous To Count (TNTC) — The total number of bacterial colonies exceeds 200 on a 47-mm diameter membrane filter used for coliform detection.

Top of Bank — The break in slope between the bank and the surrounding terrain.

Top of Dam — The elevation of the uppermost surface of a dam excluding any parapet wall, railings, etc.

Top of the Aquifer — The uppermost point at which saturated conditions are found.

Topographic Apex — The head or highest point on an active alluvial fan.

Topographic Maps — Maps with lines showing equal elevation or a region's relief; also showing natural and man-made surface features, including hills, valleys, rivers, and lakes; and man-made features such as canals, bridges, roads, cities, etc.

Topographic Maturity — See *Maturity*.

Topographic Old Age — See *Old Age*.

Topography — (1) The arrangement of hills and valleys in a geographic area. (2) The general configuration of the land surface including relief and position of natural and man-made features.

Topside — (Nautical) The surface of a ship's hull above the water line.

Tornado — (1) A rotating column of air usually accompanied by a funnel-shaped downward extension of a Cumulonimbus Cloud and having a Vortex several hundred yards in diameter whirling destructively at speeds of up to 500 miles per hour (800 kilometers per hour). (2) A violent thunderstorm in western Africa or nearby Atlantic waters. (3) A whirlwind or hurricane. Also referred to as a twister. Scientists rank a tornado's intensity and estimate its wind speed based on observed damage, using a scale developed by the late University of Chicago researcher Tetsuya Theodore Fujita. The rankings for tornadoes are presented in the follow table:

Tornado Measure	Wind Speeds	Damage Assessment
FO: Gale Tornado	40-72 miles per hour	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages signs.
F1: Moderate Tornado	73-112 miles per hour	Damage: Peels roof coverings; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2: Significant Tornado	113-157 miles per hour	Damage: Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light objects become missiles
F3: Severe Tornado	158-206 miles per hour	Damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted.
F4: Devastating Tornado	207-260 miles per hour	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown; large missiles generated.
F5: Incredible Tornado	261-318 miles per hour	Strong frame houses lifted off foundations and carried considerable distances; automobile-size missiles fly through the air for more than 100 meters; trees debarked; steel-reinforced concrete structures badly damaged.

F6: "Inconceivable"	Up to 379 miles per hour	Although he called it inconceivable, Fujita left open the possibility a tornado could cause a small area of damage even worse than F5 intensity. But he said evidence of an F6 tornado, with wind speeds up to 379 miles per hour, would probably be masked by damage from surrounding F4 and F5 winds.

On average, only one F5 tornado hits the United States each year. F5 twisters struck in 1999 in Norman, Oklahoma, in 1998 in Waynesboro, Tennessee and Pleasant Grove, Alabama; in 1997 in Jarrell, Texas; in 1996 in Oakfield, Wisconsin; in 1992 in Chandler, Minnesota; and in 1990 in Plainfield, Illinois, Goessel, Kansas, and Hesston, Kansas. In one of the worst U.S. tornadoes on record, seven F5s struck the Midwest on April 3, 1974, including at Xenia, Ohio.

Torrent — (1) A turbulent, swift-flowing stream. (2) A heavy downpour; a deluge.

Tortuosity — (1) The difference between the actual length of a meandering stream and a theoretical straight course. (2) Sinuosity of the actual flow path in porous medium; it is the ratio of the length of the flow path divided by the length of the sample.

Tortuosity Ratio — See *Sinuosity Ratio*.

TOT — See *Time of Travel*.

Total Available Chlorine — The sum of the chlorine forms present as free available chlorine and combined available chlorine.

Total Carbon (TC) — (Water Quality) A measure of the amount of carbon-containing compounds in water. The measure includes both organic and inorganic forms of carbon as well as compounds that are soluble and insoluble. The typical laboratory analysis involves the conversion of all forms of carbon to carbon dioxide and the subsequent measurement of the carbon dioxide produced. The parameter represents an estimate of the strength of wastewater and the potential damage that an effluent can cause in a receiving stream or other body of water as a result of the removal of *Dissolved Oxygen* from the water. The measurement of total carbon requires less sample, is more rapid, and yields more reproducible results than the measurement of either the *Chemical Oxygen Demand (COD)* or the *Biochemical Oxygen Demand (BOD)*. Also see *Total Organic Carbon (TOC)*.

Total Coliform — The *Escherichia coli* and similar gram negative bacteria that are normal inhabitants of fecal discharges. The total coliform group is recognized in the drinking water standards of public health criteria.

Total Coliform Bacteria — A particular group of bacteria that are used as indicators of possible sewage pollution. This group includes coliforms that inhabit the intestine of warm-blooded animals and those that inhabit soils. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35 degrees Celsius. In the laboratory, these bacteria are defined as all the organisms that produce colonies with a golden-green metallic sheen within 24 hours when incubated at 35 degrees Celsius plus or minus 1 degree Celsius on M-Endo medium (nutrient medium for bacterial growth). Their concentrations are expressed as the number of colonies per 100 mL of sample.

Total Constituent — The total amount of a given constituent in a representative suspended-sediment sample, regardless of the constituent's physical or chemical form. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent present in both the dissolved and suspended phases of the sample. A knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to judge when the results should be reported as "total". (Not that the word "total" serves a double meaning here, first indicating that the sample consists of a suspended-sediment mixture and second that the analytical method determined all of the constituent in the sample.)

Total Discharge — The quantity of a given constituent, measured as dry mass or volume, that passes a stream cross section per unit of time. When referring to constituents other than water, this term needs to be qualified, such as "total sediment discharge", "total chloride discharge", etc.

Total Dissolved Solids (TDS) — (Water Quality) (1) All of the dissolved solids in water. TDS is measured on a sample of water that has passed through a very fine mesh filter to remove suspended solids. The water passing through the filter is evaporated and the residue represents the dissolved solids. Also see *Specific Conductance*. (2) A measure of the amount of material dissolved in water (mostly inorganic salts). Typically aggregates of carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrates, etc. of calcium, magnesium, manganese, sodium, potassium, and other cations which form salts. The inorganic salts are measured by filtering a water sample to remove any suspended particulate material, evaporating the water, and weighing the solids that remain. An important use of the measure involves the examination of the quality of drinking water. Water that has a high content of inorganic material frequently has taste problems and/or water hardness problems. As an example, water that contains an excessive amount of dissolved salt (sodium chloride) is not suitable for drinking. High TDS solutions have the capability of changing the chemical nature of water. High TDS concentrations exert varying degrees of osmotic pressures and often become lethal to the biological inhabitants of an aquatic environment. The common and synonymously used term for TDS is "salt". Usually expressed in milligrams per liter. (3) A term that expresses the quantity of dissolved material in a sample of water, either the residue on evaporation, dried at 356 degrees Fahrenheit (180 degrees Celsius), or, for many waters that contain more than about 1,000 mg/e, the sum of the chemical constituents. Also see *Hard Water* and *Salinity*.

Total Dynamic Head (TDH) — When a pump is lifting or pumping water, the vertical distance (in feet) from the elevation of the energy grade line on the suction side of the pump to the elevation of the energy grade line on the discharge side of the pump. The total dynamic head is the static head plus pipe friction losses. *Static Head* is the vertical distance between water surfaces when the water is not moving.

Total Gross Reservoir Capacity — The total amount of storage capacity available in a reservoir for all purposes from the streambed to the normal water or normal pool surface level. It does not include surcharge, but does include dead storage.

Total Hardness — The total dissolved salts in water, expressed as total parts of dissolved salts in a million parts of water. Also see

Hard Water.

Total Head — Energy contained by fluid because of its pressure, velocity, and elevation, usually expressed in feet of fluid (foot-pounds per pound).

Total in Bottom Material — The total amount of a given constituent in a representative sample of bottom material. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent determined. A knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to judge when the results should be reported as “total in bottom materia”.

Total Inorganic Carbon (TIC) — (Water Quality) The total amount of inorganic salts of carbonates and bicarbonates present in water without regard as to whether the salts are in suspended particulate form or dissolved. Water that contains an excessive amount of these salts is considered to be *Hard Water*. The dissolved materials interfere with the functioning of soaps and detergents and can form adherent scale in boilers, pipes, and steam equipment.

Total Inorganic Nitrogen (TIN) — A measure of the total *Nitrate*, *Nitrite*, and *Ammonia* concentrations of a body of water, typically measured in milligrams per liter (mg/l) or micrograms per liter (µg/l). From the point of view of a planktonic algae, nitrate, nitrite, and ammonia are all very suitable sources of nitrogen for growth. Also see *Carlson's Trophic State Index (TSI)*.

Total Inorganic Phosphate (TIP) — A measure of the concentration of usable phosphorus (soluble *Phosphates*) contained in a body of water. Soluble phosphates readily contribute to algae growth in water. Also see *Carlson's Trophic State Index (TSI)*.

Total Kjeldahl Nitrogen (TKN) — The total concentration of nitrogen in a sample present as ammonia or bound in organic compounds.

Total Load — All of a constituent in transport. When referring to sediment, it includes suspended load plus bed load.

Total Maximum Daily Load (TMDL) [EPA] — (Water Quality) (1) The total allowable pollutant load to a receiving water such that any additional loading will produce a violation of water-quality standards. (2) The maximum quantity of a particular water pollutant that can be discharged into a body of water without violating a water quality standard. The amount of pollutant is set by the *U.S. Environmental Protection Agency (EPA)* when it determines that existing, *Technology-Based* effluent standards on the water pollution sources in the area will not achieve one or more *Ambient Water Quality Standards*. The process results in the allocation of the TMDL to the various *Point Sources (PS)* of pollutants in the area. A water quality criteria enforcing TMDL requirements provides the specificity for water quality analysis and planning in order to more accurately determine the specific pollution reductions that are necessary to attain or maintain water quality standards. Under section 303(d) of the *Clean Water Act (CWA)*, states are required to establish TMDLs for impaired waters. The TMDL process includes legal requirements for public participation and implementation through *National Pollutant Discharge Elimination System (NPDES)* permits.

Total Maximum Daily Loads (TMDL) Program — See *Clean Water Act (CWA) Section 303(d) [EPA]*.

Total Nitrogen — The sum of all nitrogen forms.

Total Organic Carbon (TOC) — (Water Quality) A measure of the amount of organic materials suspended or dissolved in water. The measure is very similar to the assay of the total carbon content; however, samples are acidified prior to analysis to remove the inorganic salts of *Carbonates* and *Bicarbonates*. The assay of total organic carbon represents an estimation of the strength of wastewater and the potential damage that an effluent can cause in a receiving body of water as a result of the removal of *Dissolved Oxygen* from the water. The measurement of total organic carbon requires less sample, is more rapid, and yields more reproducible results than the measurement of either the *Chemical Oxygen Demand (COD)* or the *Biochemical Oxygen Demand (BOD)*. As a pollution indicator, this method is more reliable than the assay of *Total Carbon (TC)* when the wastewater contains high amounts of total inorganic carbon as well.

Total Particulate Phosphorus — Total phosphorus content of material retained on a filter of a specific size.

Total Phosphorus — The sum of all phosphorus forms.

Total Porosity — (Geology) The percentage of the total bulk volume of a given sediment or rock that consists of interstices.

Total Recoverable Constituent — The amount of a given constituent that is in solution after a representative suspended-sediment sample has been digested by a method (usually using a dilute acid solution) that results in dissolution of only readily soluble substances. Complete dissolution of all particulate matter is not achieved by the digestion treatment, and thus the determination represents something less than the “total” amount (that is, less than 95 percent) of the constituent present in the dissolved and suspended phases of the sample. To achieve comparability of analytical data, equivalent digestion procedures are required of all laboratories performing such analyses because different digestion procedures are likely to produce different analytical results.

Total Residual Chlorine — The amount of available chlorine remaining after a given contact time. The sum of the combined available residual chlorine and the free available residual chlorine. Also see *Residual Chlorine*.

Total Sediment Discharge — The total quantity of sediment passing a section in a unit of time.

Total Sediment Load — The sum of the *Bed Load* and the *Suspended Sediment Load (Discharge)*.

Total Soil Water Potential — The work per unit quantity of pure water that has to be done to change its energy status to that of soil water at the point under consideration. This equals the sum of matric, gravity, pressure, osmotic, and overburden potentials.

Total Solids (TS) — (Water Quality) A measure of the amount of material that is either dissolved or suspended in a water sample, obtained by allowing a known volume to evaporate and then weighing the remaining residue. Total solids equals the sum of the measurements of *Total Dissolved Solids (TDS)* and *Total Suspended Solids (TSS)*.

Total Storage (Reservoir) — The volume of storage below the maximum designed water surface level, including *Dead Storage*.

Total Suspended Particles — A method of monitoring particulate matter by the total weight of a sample of water.

Total Suspended Solids (TSS) — (Water Quality) Solids, found in waste water or in a stream, which can be removed by filtration. The origin of suspended matter may be man-made wastes or natural sources such as silt. Compare to *Total Dissolved Solids (TDS)*.

Total Toxicity — Toxicity as determined by exposing aquatic organisms to samples or dilutions of instream water or treated effluent.

Total Trihalomethane (TTHM) — (Water Quality) The sum of the concentrations of individual members of a family of halogenated derivatives of methane in drinking water. The concentrations of the following are employed to compute the sum in milligrams per liter (mg/l): chloroform (CHCl_3), dichlorobromomethane (CHCl_2Br), dibromochloromethane (CHClBr_2), and bromoform (CHBr_3). See *Trihalomethanes (THMs)*.

Total Water Used — Total water withdrawal which does not include recirculation.

Totalizer — A device or meter that continuously measures and calculates (adds) total flows in gallons, million gallons, cubic feet, or some other unit of volume measurement. Also called an *Integrator*.

Totalizing Meters — A water measuring (headgate or surface tailwater runoff point) device which registers or accumulates total flow (for example, in acre-feet).

Township — A territorial subdivision, generally considered six miles long, six miles wide, and containing 36 *Sections*, each section 1 mile square (640 acres). The Township designation is part of a description of the location of land using the survey system (*Public Land Survey System – PLSS*) of the United States Government and includes the 40-acre subdivision within a *quarter*, *section*, *township* and *range*. The public land survey system is based on the concept of a township as a square parcel of land six miles on each side. Its location is established as being so many six-mile units east of a north-south line (called the *meridian*) and so many six-mile units north or south of an east-west line (called the *baseline*). The township is described by township and range, e.g., T.4N, R.23E. Each township is further divided into 36 parts called sections one mile square (each section measuring 5,280 feet on each side). A typical section contains 640 acres; however, some sections may contain more or less acreage than 640. Also see *Section*.

Township Line — In the generally recognized *U.S. Public Land Survey*, every 24 miles a station is indicated measuring both east and west from a predetermined principal meridian. Similar measurements are also taken north and south from a predetermined base line. In this manner a succession of quadrilaterals are formed, each roughly 24 miles square. Each of these is subdivided into 16 smaller quadrilaterals roughly six miles square. In this system of grid lines, north-south lines become *Range Lines* and east-west lines become *Township Lines*.

Toxaphene — (Water Quality) A chemical that causes adverse health effects in domestic water supplies and is toxic to fresh water and marine aquatic life.

Toxemia — A pathological condition in a person or animal caused by the presence of a toxic substance in the body.

Toxic — (1) A substance which is poisonous to an organism. (2) Describing a material that can cause acute or chronic damage to biological tissue following physical contact or absorption. (3) Substances that even in small quantities may poison, cause injury, or cause death when eaten or ingested through the mouth, absorbed through the skin or inhaled into the lungs. (4) A substance which is poisonous to a living organism. Toxic substances may be classified in terms of their physiological action, such as irritants, asphyxiants, systemic poisons, and anesthetics and narcotics. Irritants are corrosive substances which attack the mucous membrane surfaces of the body. Asphyxiants interfere with breathing. Systemic poisons are hazardous substances which injure or destroy internal organs of the body. The anesthetics and narcotics are hazardous substances which depress the central nervous system and lead to unconsciousness.

Toxic Materials — Any liquid, gaseous, or solid substance or substances in a concentration which, when applied to, discharged to, or deposited in water or another medium may exert a poisonous effect detrimental to people or to the propagation, cultivation, or conservation of animals, or other aquatic life.

Toxic Pollutant — Those pollutants or combinations of pollutants, including disease causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the Administrator of *U.S. Environmental Protection Agency (EPA)*, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring. (Definition from Section 502(13) of the *Clean Water Act*.)

Toxic Salt Reduction — Decreasing harmful concentrations of toxic salts in soils, usually by leaching and with or without the addition of soil amendments.

Toxic Substance — A chemical or mixture that may represent an unreasonable risk of injury to health or the environment.

Toxicant — (1) A harmful substance or agent that may injure an exposed organism. (2) Any chemical that has the potential of causing acute or chronic adverse effects in animals, plants, or humans.

Toxicity — (1) The quality or degree of being poisonous or harmful to plant, animal or human life. (2) The ability of a chemical substance to cause acute or chronic adverse health effects in animals, plants, or humans when swallowed, inhaled or absorbed. (3) The occurrence of lethal or sublethal adverse effects on representative, sensitive organism due to exposure to *Toxic Materials*. Adverse effects caused by conditions of temperature, dissolved oxygen, or nontoxic dissolved substances are excluded from the definition of toxicity.

Toxicity Assessment — Characterization of the toxicological properties and effects of a chemical, including all aspects of its absorption, metabolism, excretion and mechanism of action, with special emphasis on establishment of dose-response characteristics.

Toxicity Characteristic Leaching Procedure (TCLP) — A test that measures the mobility of organic and inorganic chemical contaminants in wastes. The test, designed by the *U.S. Environmental Protection Agency (EPA)*, produces an estimate of the potential for *Leachate* formation by a waste if it is placed in the ground. If the TCLP is applied to a solid waste sample and the extract leached from the waste or the solid waste sample itself contains concentrations of specified materials exceeding allowable levels, the waste is defined as a *Hazardous Waste*, meeting the toxicity characteristic.

Toxicology — (1) The science and study of poisons control. (2) The study of chemical agents that cause diminished health and death in organisms, including humans. The study involves the chemistry, recognition, identification, measurement, distribution, and

- metabolism of hazardous substances to which organisms are exposed. The science also includes the prediction of potential adverse effects of chemicals on organisms, including humans.
- Toxin** — Any of a variety of unstable, poisonous compounds produced by some microorganisms and causing certain diseases or physical reactions.
- Trace** — A hydrograph or similar plot for an extended-range time horizon showing one of many scenarios generated through an ensemble forecast process.
- Trace (of Precipitation)** — (Meteorology) (1) The amount of rainfall or other form of precipitation which occurs when the quantity is so small that it cannot be measured in the rain gage. (2) A rainfall amount less than 0.01 of an inch.
- Trace Elements** — (1) Elements essential to plant or animal life but required only in small amounts, such as the trace amounts of manganese, zinc, iron, molybdenum, cobalt, and copper. (2) Elements present in minor amount in the earth's crust; all elements except the eight abundant rock-forming elements, O, Si, Al, Fe, Ca, Na, K, and Mg. Also known as minor elements and accessory elements.
- Trace Metals** — A general term for metals found in small quantities (less than 1 milligram per liter — mg/l) in water, usually due to their insolubility.
- Tracer** — A substance added to another material for purposes of determining flow characteristics of the stream. If radioactive, the tracer can be found and measured by use of simple radiation-detecting instruments.
- Tract** — An expanse of land or water.
- Tractive Force** — The drag on a stream bank caused by passing water, which tends to pull soil particles along with the stream flow.
- Tragedy of the Commons** — The concept that no one takes responsibility for things that everybody owns.
- Train Echoes (Training)** — Repeated areas of rain, typically associated with thunderstorms, that move over the same region in a relatively short period of time and are capable of producing excessive rainfall totals. Train(ing) echoes can frequently be a source of flash flooding.
- Tranquil Flow** — A term for water flowing at a rate that is lower than the velocity of a long surface wave in still water. Also referred to as *Streaming Flow* or *Subcritical Flow*.
- Transbasin** — Generally, the transfer of water from one river basin to another river basin.
- Transfer** — (1) Refers to the movement of water from one reservoir or storage facility to another. (2) A movement of water or water rights that involves a change in point of diversion, a change in type of use, or a change in location of use.
- Transfer (Water Right)** — (1) The process of transferring a water right from one person to another. (2) A passing or conveyance of title to a water right; a permanent assignment as opposed to a temporary lease or disposal of water. Most states require that some formal notice or filing be made with an appropriate state agency so that the transaction is officially recorded and the new owner is recorded as the owner of the water right.
- Transfer Rate** — The use-rate for a water right that is transferred from an owner to a buyer.
- Transfer or Change in Use (Water Right)** — Generally, this term refers to a change in the place of use or purpose of use of water authorized by a particular water right. If done in the proper manner, the change can be made without loss of priority.
- Transgressive Overlap** — See *Onlap*.
- Transient Flow** — Unsteady flow during a change from a steady-flow state to another steady-flow state.
- Transient Non-Community Water System** — A water system which provides water in a place such as a gas station or campground where people do not remain for long periods of time. These systems do not have to test or treat their water for contaminants which pose long-term health risks because fewer than 25 people drink the water over a long period. They still must test their water for microbes and several chemicals. Also see *Transient Water System*.
- Transient Water System** — A non-community water system that does not serve 25 of the same nonresidents per day for more than six months per year. Also called a *Transient Non-Community Water System (TNCWS)*.
- Transition Zone** — The intervening area between distinct environments.
- Transitional Storage Reserve** — The quantity of water in storage in a particular groundwater aquifer that is extracted during the transition period between natural equilibrium conditions and new equilibrium conditions with groundwater pumped at perennial yield levels.
- Transitional Zone** — Area of a reservoir between the *Riverine* and *Lacustrine Zones*; current velocities are intermediate, significant sedimentation occurs, light penetration increases and primary productivity increases.
- Transitory Channel Deposits** — In valley sediment deposition, transitory channel deposits consist of primarily bed load temporarily at rest; part may be preserved in more durable channel fills or lateral accretions. See *Valley Sediment Deposits*.
- Translatory Wave** — (Hydraulics) (1) A gravity wave that propagates in an open channel and results in appreciable displacement of the water in a direction parallel to the flow. (2) A wave, such as a flood wave, whose water particles constantly progress in the direction of the wave movement; a characteristic of unsteady flow. A gravity wave that propagates in an open channel and results in displacement of water particles in a direction parallel to the flow.
- Transmissibility (Groundwater)** — (1) The flow capacity of an *Aquifer* measured in volume per unit time per unit width. Equal to the product of *Permeability* times the saturated thickness of the aquifer. (2) The capacity of a rock or ground formation to transmit water under pressure. The coefficient of transmissibility is the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer one foot wide, extending the full saturated height of the aquifer under a hydraulic gradient of 100 percent. A *Hydraulic Gradient* of 100 percent means a one foot drop in head in one foot of flow distance. See *Transmissivity*.
- Transmission Lines** — Pipelines that transport raw water from its source to a water treatment plant, then to the distribution grid system.
- Transmissivity, also Coefficient of Transmissivity (τ)** — (1) The ability of an aquifer to transmit water. (2) The capacity of an

aquifer to transmit water; equal to the hydraulic conductivity times the aquifer thickness. (3) The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit *Hydraulic Gradient*. It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the flow paths. Also, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivity values are given in gallons per minute through a vertical section of an aquifer 1 foot wide and extending the full saturated height of an aquifer under a hydraulic gradient of one in the *English Engineering System*; in the *Standard International System*, transmissivity is given in cubic meters per day through a vertical section of an aquifer 1 meter wide and extending the full saturated height of an aquifer under hydraulic gradient of one. It is a function of properties of the liquid, the porous media, and the thickness of the porous media. Also see *Coefficient of Transmissivity*.

Transparency — The portion of light that passes through water without distortion or absorption. A measure of the *Turbidity* of water or other liquids.

Transpiration — (1) The process in which plant tissues give off water vapor to the atmosphere as an essential physiological process. (2) The movement of water from the soil or groundwater reservoir via the stomata in plant cells to the atmosphere. (3) The quantity of water absorbed, transpired, and used directly in the building of plant tissue during a specified time period. It does not include soil evaporation. (4) The process by which water vapor escapes from a living plant, principally through the leaves, and enters the atmosphere. As considered practically, transpiration also includes *Guttation*. Transpiration, combined with *Evaporation* from the soil, is referred to as *Evapotranspiration*.

Transpiration Ratio — The number of pounds of water required for transpiration per pound of dry plant tissue produced.

Transport — Conveyance of solutes and particles in flow systems.

Transport Capacity — The ability of a stream to transport a *Suspended Load*, expressed in terms of the total weight of the suspended particles.

Trap — (1) A device for sealing a passage against the escape of gases, especially a U-shaped or S-shaped bend in a drainpipe that prevents the return flow of sewer gas by means of a water barrier. (2) (Wastewater Treatment) In the wastewater collection system of a building, plumbing codes require every drain connection from an appliance or fixture to have a trap. The trap in this case is a gooseneck that holds water to prevent vapors or gases in a collection system from entering the building. Various other types of special traps are used in collection systems such as a *Grit Trap* or *Sand Trap*.

Trap Efficiency (of Reservoirs) — The ratio of sediment retained within the reservoir to the sediment inflow of the reservoir expressed as a percentage.

Trash Line — An indication on a beach of the highest level of the tide, as shown by the deposit of a line of waterborne debris at this point.

Trash Rack — (1) A barrier placed at the upstream end of a culvert to trap debris but allow water to flow through. (2) A screen located at an intake fixture of a dam spillway or other such conduit to prevent the ingress of debris.

Travel Time — The time required for a flood wave to travel from one location to a subsequent location downstream.

Travertine — A form of calcium carbonate (CaCO_3), such as aragonite or calcite, that is precipitated out of hot mineral springs as it cools upon reaching the ground surface. Travertine becomes colored by minerals in the water and by biological action and is sometimes quarried for use as decorative stone. Also see *Tufa*.

Tray Tower — (Air Quality) An air pollution control device in which contaminated air is passed through a tower containing substances (packing) possessing large surface area. Water is passed over the packing material in a countercurrent fashion, i.e., in a direction opposite to the passage of the air, and the air contaminants are then absorbed into the liquid. Also referred to as *Absorption Tower*, *Packed Tower*, or *Spray Tower*.

Treated (Wastewater) Effluent — Water that has received primary, secondary, or advanced treatment to reduce its pollution or health hazards and is subsequently released from a wastewater facility after treatment.

Treated Wastewater — Wastewater that has been subjected to one or more physical, chemical, and biological processes to reduce its pollution of health hazard.

Treatment — Any method, technique, or process designed to remove solids and/or pollutants from wastestreams and effluents. Also see *Pretreatment*, *Primary Wastewater Treatment*, *Secondary Wastewater Treatment*, and *Tertiary Wastewater Treatment*.

Treatment Facility — Any place(s) where a community water system or *Nontransient-Noncommunity Water System* alters the physical or chemical characteristics of the drinking water. Chlorination may be considered as a function of a *Distribution System*.

Treatment Plant — A structure built to treat wastewater before discharging it into the environment.

Treatment Tank — A water-tight tank designed to retain sewage long enough for satisfactory bacterial decomposition of the solids to take place. *Septic Tanks* and *Aerobic Sewage Treatment Tanks* are examples.

Treatment Technique [EPA] — (Water Quality) A required process intended to reduce the level of a contaminant in drinking water.

Tree — A woody plant which at maturity is usually 6 meters (20 feet) or more in height and generally has a single trunk, unbranched for 1 m or more above the ground, and a more or less definite crown; e.g., red maple (*Acer rubrum*), northern white cedar (*Thuja occidentalis*).

Tree Line — The dividing point, caused by changing latitudes or altitudes, between areas with environmental conditions supporting trees and those that do not. The tree line in North America defined by latitude runs across northern Canada. Tree lines also exist at lower latitudes because of the altitudes in such places as in the Rocky Mountains and the Sierra Nevada Mountains.

Tree Ring Reconstruction of Streamflow — See *Dendrohydrological Reconstruction*.

Trellis Drainage Pattern — A pattern of natural stream courses in which the main streams and elongated secondary tributaries run parallel and are intersected at more or less right angles by the primary tributary streams. Also referred to as a *Grapevine Drainage Pattern* or *Espalier Drainage Pattern*. Also see *Trellis Pattern*.

Trellis Pattern — A roughly rectilinear arrangement of stream courses in a pattern reminiscent of a garden trellis, developed in a

- region where rocks of differing resistance to erosion have been folded, beveled, and uplifted. Also see *Trellis Drainage Pattern*.
- Tremie** — A device used to place concrete or grout under water.
- Tremie Pipe** — A pipe that carries grout to the bottom of the hole or well and allows placement of the grout under pressure from the bottom to the top of the hole or well; a pipe that carries gravel pack to the screened area of the well.
- Trend** — (1) A statistical term referring to the direction or rate of increase or decrease in magnitude of the individual members of a time series of data when random fluctuations of individual members are disregarded. (2) A unidirectional increasing or decreasing change in the average value of a variable.
- Trespass** — Any voluntary transgression of law or rule, as to enter wrongfully upon another's land or to infringe upon another's rights to use water.
- Tributary** — (1) A stream which joins another stream or body of water. (2) A stream that feeds, joins, or flows into a lake or into a larger stream at any point along its course. (3) A stream or other body of water, surface or underground, which contributes its water, even though intermittently and in small quantities, to another and larger stream or body of water. Also referred to as *Sidestream* or *Feeder*. (4) (Geology) A valley that contains a tributary stream.
- Tributary Glacier** — A *Glacier* that merges with a larger glacier.
- Trichloroethane (TCE)** — (Water Quality) An organic chemical used as a cleaning solvent that causes adverse health effects in domestic water supplies.
- Trickle** — To flow or fall in drops or in a thin stream.
- Trickle Channel** — A longitudinal channel constructed along the center and lowest part of a channel or through a detention or retention facility and intended to carry low flows. Also referred to as a *Cunette*.
- Trickle (Drip) Soil Absorption System** — A shallow slow rate pressure-dosed system used for land application of treated wastewater, particularly under soil conditions unsuitable for normal septic tanks and gravity-fed soil absorption systems. In agriculture, drip soil irrigation systems irrigate crops by means of a network of shallow underground pipes fed by a pump. Such a system conserves water used in crop irrigation by applying it at a controlled rate in the root zone, minimizing evaporation and percolation losses. In the drip soil absorption system, the filtered effluent is delivered via supply lines to a subsurface drip field consisting of parallel rows of polyethylene tubing, known as "dripper lines". Emitters are installed along these tubes to uniformly distribute and control the flow of effluent. The key to the effective operation of drip soil absorption systems is the slow and controlled rate at which it applies effluent over a large surface area, allowing relatively shallow placement of the dripper lines and long-term use without risk of saturating soils. This allows such systems to be effectively used for subsurface irrigation of trees, shrubs, and gardens in arid regions. Also see *Septic Tank Soil Absorption System (ST-SAS)*.
- Trickle Tube** — A small diameter pipe to take water by gravity from a farm pond to a drinking receptacle without allowing livestock access to the pond.
- Trickling Filter** — (Water Quality) A means of secondary sewage treatment used to remove soluble or colloidal organic compounds. The filter consists of a bed of small rocks or other suitable material provides a surface for the growth of microorganisms. As the clarified wastewater (from which the particulate material has been removed) passes through the trickling filter, organic material is metabolized by aerobic processes by the attached organisms. Also see *Secondary Wastewater Treatment*.
- Trihalomethanes (THMs)** — (Water Quality) (1) One of a family of organic compounds named as derivatives of methane. THMs are generally the by-product from *Chlorination* of drinking water that contains organic material. The resulting compounds (THMs) are suspected of causing cancer. Any of several synthetic organic compounds formed when chlorine or bromine combine with organic materials in water. (2) Any of several synthetic organic compounds formed when chlorine combines with organic materials in water during the disinfection process. The most common THM is chloroform. (3) A group of low-molecular-weight, halogenated hydrocarbons, derivatives of methane, CH₄, in which three halogen atoms (chlorine, bromine, or iodine) are substituted for three of the hydrogen atoms. The subsequent substances typically include the compounds of chloroform (CHCl₃), dichlorobromomethane (CHCl₂Br), dibromochloromethane (CHClBr₂), and bromoform (CHBr₃). The sum of these four compounds is referred to as *Total Trihalomethanes (TTHMs)*. The group includes suspect human *Carcinogens*. Small amounts of THMs have been detected in raw water collected from surface sources used as a public water supply, and concentrations have been shown to be increased during the chlorination phase of the water purification process. The most marked increase during chlorination of drinking water has been recorded in water containing suspended particles and/or humic substances.
- Trim** — The angle to the water at which a boat rides. The crew and gear should be positioned so that the boat is level from side to side, and slightly heavier in the bow than in the stem.
- Tri-Partite Agreement [Lahontan Valley, Nevada]** — The 50-year agreement among Truckee-Carson Irrigation District (TCID), Nevada State Board of Fish and Game Commissioners (currently the Nevada Board of Wildlife Commissioners as part of the Nevada Division of Wildlife, NDOW), and U.S. Fish and Wildlife Service (USFWS) regarding the establishment, development, operation, and maintenance of *Stillwater National Wildlife Management Area*, dated November 26, 1948. In 1960 the management of this area was changed to a two-party agreement between USFWS and NDOW.
- Trihalomethanes (THM)** — Natural organic compounds found in all surface and groundwaters. These compounds may react with *Halogens* (such as chlorine) to form *Trihalomethanes (THMs)*; they must be present in order for THMs to form.
- Triphibian** — Designed to operate on land, water, or in air.
- Triple Point** — The condition of temperature and pressure under which the gaseous, liquid, and solid phases of a substance can exist in equilibrium. For water, at a standard pressure of one (1) atmosphere, this represents a temperature of 273.16 Kelvin (K), 0.01°C (Celsius), and 32.02°F Fahrenheit. Also see *Temperature Scale, Celsius [Temperature Scale], Centigrade [Temperature Scale], and Fahrenheit [Temperature Scale]*.
- Tritium** — An isotope of hydrogen with an atomic weight approximately three times that of ordinary hydrogen. It is moderately radioactive, with a half life of 12.5 years.

Trompe — An apparatus in which water falling through a perforated pipe entrains air into and down the pipe to produce an air blast for a furnace or forge.

Trophic Diversity — (Biodiversity Measure) The diversity (richness and evenness) of species within each trophic level (primary producer, primary consumer, secondary consumer, tertiary consumer, decomposer, detritivore). The flow or cycling of energy follows along food webs. Organisms within a food web are associated with a trophic level which can be defined as all the organisms that have the same basic life strategy as defined by the number of levels away from the original source of energy (i.e., the sun). This measure provides an index of the diversity of processes.

(Mean) Trophic State Index (TSI) — A measure of *Eutrophication* of a body of water using a combination of measures of water transparency or turbidity (using *Secchi Disk* depth recordings), *Chlorophyll-a* concentrations, and total phosphorus levels. TSI measures range from a scale 20–80 (referred to as *Carlson's Trophic State Index*). Degrees of eutrophication typically range from *Oligotrophic* water (maximum transparency, minimum chlorophyll-a, minimum phosphorus) through *Mesotrophic*, *Eutrophic*, to *Hypereutrophic* water (minimum transparency, maximum chlorophyll-a, maximum phosphorus).

Trophogenic Region — The area of a body of water where organic production from mineral substances takes place on the basis of light energy and photosynthetic activity.

Trophic State — A measure of the *Eutrophication* in a lake or other water body. The *Carlson's Trophic State Index (TSI)* is the most widely used index for eutrophication in lake monitoring programs, and is based on epilimnetic chlorophyll a concentration, total phosphorus concentration, and Secchi depth. Index values range from below 0 (ultraoligotrophic) to above 100 (hypereutrophic). Each of three measures (chlorophyll, total P, Secchi) is used to calculate an independent index, and the indices can be compared to identify whether algal growth is limited by phosphorus, light, or other nutrients. Chlorophyll is the most accurate and is the preferred indicator of trophic state. Total phosphorus and Secchi depth indices are also used as surrogates in the absence of chlorophyll data, and can be used to identify factors contributing to algal growth when all three are measured.

Trophic State Index — Any numerical index for estimating *Trophic State* of a lake.

Tropholytic — (Ecology) Relating to the deeper region of a lake, in which the primary energy source is organic matter.

Tropical Dry Forest — Similar to *Tropical Rain Forest* in as much as characterized by high temperatures throughout the year, but there is also a well-defined dry season that limits plant growth and animal activity. Also, unlike the tropical rain forest, many of the trees and plants in this type of *Bioclimatic Zone* are *Deciduous*. Also see *Biome*.

Tropical Rain Forest — (Ecology) (1) A region found widely in equatorial lowlands throughout the world, with heavy year-round rainfall and very little temperature variation from season to season; characterized by heavy tree growth that admits little light to the forest floor, so that there is minimal undergrowth. Tropical rain forests have a greater range of plant and animal life than any other habitat; roughly half the world's total species live in such areas. (2) A dense forest occupying a tropical region with high temperatures throughout the year and a maximum annual rainfall of in excess of 200 inches. Plants are typically *Evergreen*, retaining their leaves throughout the year. Tropical rain forests represent the richest natural terrestrial environment in terms of the amount of *Biomass* and the number of species present. These forests occupy the equatorial regions of South and Central America, Central Africa, and Southeast Asia. Such forests include up to five times the number of species of trees as found in temperate regions and an unrivaled number of species of associated plants and animals. Paradoxically, the soil of the typical rain forest is very thin and low in plant nutrients. The temperatures usually remain between 70°Fahrenheit and 95°Fahrenheit the year round, and the rainfall typically varies between 50 and 200 inches per year. The destruction and disturbance of tropical rain forests are of environmental concern because of the loss of many species (some yet to be described), the conversion of the land to a semidesert condition, disruption of the climatic patterns of the region, and a worsening of the global balance in carbon dioxide production and utilization, among other factors. Also see *Biome*.

Tropopause — The boundary in the *Atmosphere* between the layer next to the surface of the earth (*Troposphere*) and the next highest layer (*Stratosphere*).

Troposphere — The lowest layer of the earth's *Atmosphere* and the site of all weather processes. It extends up to an altitude of about 7 miles (11 kilometers) above the polar zones and to about 10 miles (16 kilometers) above the equatorial regions and is characterized by decreasing temperature with increasing altitude. The *Tropopause* forms the boundary between troposphere and *Stratosphere*. The troposphere contains 80 percent of all the mass of the gases in the atmosphere and 99 percent of the water vapor.

Trough — (1) A long, narrow, generally shallow receptacle for holding water or feed for animals; any of various similar containers for domestic or industrial use. (2) A gutter under the eaves of a roof. (3) A long, narrow depression, as between waves or ridges. (4) A long but shallow depression in the bed of the sea. (5) (Meteorology) An elongated region of relatively low atmospheric pressure, often associated with a front.

Troy Weight — A system of units of weight in which the grain is the same as in the *Avoirdupois Weight* system and the pound contains 12 ounces, 240 penny weights, or 5,760 grains.

TRPA — See *Tahoe Regional Planning Agency (TRPA)*.

Truckee-Carson Irrigation District (TCID) [Nevada] — The agent of the U.S. Department of the Interior *Bureau of Reclamation (USBR)* which serves the interests of the water-righted agricultural water users in the *Newlands (Irrigation) Project*, located in Churchill County, Nevada. The Newlands Project, originally named the Truckee-Carson Irrigation Project, was America's first federal reclamation project completed under the Reclamation Act of 1902. The Truckee-Carson Irrigation District has operated the Newlands Project since 1926 and is responsible for dispersing some 320,000 acre-feet of water from the Carson and Truckee rivers during normal water years. TCID is responsible for the operation of the Lake Tahoe Dam at the outlet to Lake Tahoe at Tahoe City in Placer County, California, Derby Dam on the lower Truckee River in Washoe County, Nevada, Lahontan Dam on the lower Carson River in Churchill County, Nevada, and, some six miles below Lahontan Dam, the Carson Diversion Dam which distributes the releases from Lahontan Reservoir into the project's principal "T" (T-Line) and "V" (V-Line) primary

distribution canals. Within the Newlands Projects, there are 102 miles of main canals, 312 miles of irrigation laterals, an extensive system of private ditches, 345 miles of drainage ditches, and numerous diversion dams and regulating reservoirs. TCID offices are located in Fallon, Nevada (Churchill County), and its operations are managed by a Project Manager, a board of seven members, and approximately 50 full-time employees. In 1978 the USBR canceled the contract under which TCID had operated the project since 1926. The cancellation was in response to a refusal of the farmer-dominated organization to follow federal water conservation guidelines, or *Operating Criteria and Procedures (OCAP)*. TCID has been operating under a temporary contract since 1984.

Truckee–Carson Irrigation Project [Nevada] — Original name of the *Newlands (Irrigation) Project [Nevada]*. Renamed in 1919 in honor of U.S. Senator from Nevada Francis G. Newlands and his sponsor ship of the 1902 Reclamation Act, which ultimately brought this project to Nevada. Also see *Truckee–Carson Irrigation District (TCID)*.

Truckee Division [Newlands Irrigation Project, Nevada] — The Truckee Division of the Newlands Project is located from Fernley (Lyon County) through Hazen and the Swingle Bench area, primarily in Churchill County, Nevada. It contains about 6,000 acres of water-righted land, and relies solely on water from the Truckee River, delivered through the Truckee Canal.

Truckee River Agreement [Nevada and California] — The Truckee River Agreement (1935) represents the current basis for the operation of the Truckee River, including its tributaries and diversions, between its source (Lake Tahoe) and its terminus (Pyramid Lake). Parties to this agreement include the *Truckee–Carson Irrigation District (TCID)*, serving the irrigation rights of agricultural water users of the *Newlands (Irrigation) Project [Nevada]* in Churchill County, Nevada, Sierra Pacific Power Company (SPPCo), serving primarily the municipal and industrial water needs of the cities of Reno and Sparks, Nevada, and the Washoe County Water Conservation District (WCWCD), serving the agricultural water users in the Truckee Meadows. Operation of upstream reservoirs is under the supervision of the Federal Water Master, who administers court-imposed requirements under the *Orr Ditch Decree [Nevada and California]* to supply water to achieve *Floriston Rates [California]* (mandated river flow rates) at the California–Nevada border. The 1944 Orr Ditch Decree, which incorporates the Truckee River Agreement, affirmed numerous individual water rights (both municipal and industrial and agricultural), including Truckee River diversion rights earlier than 1939. The Truckee River Agreement provides for operation of storage facilities, especially Lake Tahoe, to satisfy these rights and required the building of Boca Dam and Reservoir. The agreement further contains language intended to settle the disputes over pumping Lake Tahoe by:

- [1] Establishing the natural conditions in the bed and banks of Lake Tahoe and of the Truckee River near Tahoe City, Placer County, California, and prohibiting any alteration of such natural conditions without the approval of the Attorney General of the State of California, and, in fact, allowing parties to the agreement the right to restore these areas to their natural condition, as necessary;
- [2] Prohibiting the creation of any other outlet of Lake Tahoe in addition to the present and natural outlet at the head of the Truckee River;
- [3] Prohibiting the removal of water from Lake Tahoe for irrigation or power uses by any means other than gravity except upon the declaration of the U.S. Secretary of the Interior; and
- [4] Prohibiting the removal of water from Lake Tahoe for sanitary or domestic uses by any means other than gravity, except upon the condition that the Departments of Health of the States of Nevada and California, or other officers exercising similar authority, shall first have made and filed with the Attorney General of the State of Nevada and the Attorney General of the State of California certificates showing that a necessity for such pumping of Lake Tahoe exists.

The prescribed Floriston rates constitute the chief operational objective on the Truckee River today and originated as a turn-of-the-century flow requirement for run-of-the-river users — hydropower and a pulp and paper mill. Stored water in Lake Tahoe and Boca Reservoir is used to “make rates,” as specified in the Truckee River Agreement, when the river’s natural flow alone does not suffice. The following is a listing of the dams and reservoirs that are operated along the Truckee River and their ownership, uses, and operational criteria. Not all these reservoirs are operated as part of the Truckee River Agreement.

- [1] **Lake Tahoe** — The first dam at Lake Tahoe’s exit into the Truckee River, located at Tahoe City in Placer County, California, was constructed in the early 1870s and the existing Lake Tahoe Dam was constructed in 1913. The Lake Tahoe drainage area covers approximately 506 square miles. Water is stored only in the top 6.1 feet, from an elevation of 6,223.0 feet (the lake’s assumed natural rim above mean sea level — MSL) to an elevation of 6,229.1 feet (MSL). Total storage capacity equals approximately 744,600 acre-feet and is used to supplement Floriston rates in conjunction with natural runoff of other tributaries and Boca Dam releases. The Lake Tahoe Dam is owned by the USBR and operated under agreement by the TCID for the Newlands Project in Churchill County, Nevada. Lake Tahoe storage capacity is not considered part of the U.S. Army Corps of Engineers (COE) flood control system. Lake Tahoe waters may be exchanged for water from Prosser Creek Reservoir (the Tahoe–Prosser Exchange Agreement) in order to maintain a live stream below the Lake Tahoe Dam without adversely affecting Nevada water users’ storage. Whenever possible, Lake Tahoe releases are to maintain a minimum instream flow of 50–70 cubic feet per second (cfs) downstream from the dam (varies with season).
- [2] **Donner Lake** — The first dam on Donner Lake was built in 1877, while the current dam was constructed in the 1930s. Donner Lake drains an area of only approximately 14 square miles. Water in Donner Lake is privately owned by Sierra Pacific Power Company (SPPCo) of Reno, Nevada and TCID and is not required to be used to meet Floriston rates. The dam is jointly owned and operated by SPPCo and TCID. Lake storage levels range between 5,924 feet MSL and 5,935.8 feet MSL (providing for 9,500 acre-feet of storage capacity). The SPPCo portion of the stored water is used to supplement Reno–Sparks municipal and industrial water use; the TCID portion is used

- to supplement Newlands Project irrigation water requirements. After the lake fills, lake inflows are passed through to supplement Floriston rates. Lake storage is not part of COE flood control system. The State of California requires a minimum flow of 2–3 cfs downstream from the dam for maintaining fish habitat.
- [3] **Independence Lake** – The original Independence Lake dam was constructed in 1879 and created a storage capacity of 3,000 acre-feet. After SPPCo acquired ownership of the lake and dam in 1937, the dam was enlarged in 1939 to its present size with a total storage capacity of 17,500 acre-feet. Independence Lake drains an area of only eight square miles. Like Donner Lake water, this water is privately owned and not required to be used to meet Floriston rates; the stored waters are owned by SPPCo and supplement the SPPCo water supply for the Reno–Sparks municipal and industrial water use during droughts. The lake’s first storage priority is for 3,000 acre-feet of (original) storage; an additional 14,500 acre-feet of storage is permitted after Boca Reservoir is full and the Floriston rates and Truckee River diversion rights (Orr Ditch Decree) are satisfied. The State of California requires a minimum flow of 2 cfs downstream from the dam for maintaining fish habitat.
- [4] **Martis Creek Reservoir** – The Martis Creek Dam was constructed by the COE in 1971 and was intended to store waters from a 40 square mile drainage area to include not only Martis Creek, by the East, West, and Central Martis Creeks as well. In accordance with COE requirements, this reservoir, with a total storage capacity of 20,400 acre-feet, serves only flood control purposes. While legislation allows for other uses, only temporary storage is currently permitted due to an unsafe, leaking dam. Except during flood storage, reservoir outflows equal inflows.
- [5] **Prosser Creek Reservoir** – The Prosser Creek Reservoir was constructed by the USBR in 1962 to store waters from a 50 square mile drainage area beginning 11 miles to the west at Warren Lake. The reservoir, with a total capacity of 29,800 acre-feet, is owned and operated by the USBR for three purposes: (a) as part of the COE Truckee River flood control program; (b) the storage of water under the terms of the Tahoe–Prosser Exchange Agreement (which provides that a portion of this water, when available, may be used to meet Floriston rates in lieu of making such releases from Lake Tahoe); and (c) to meet the spawning flow needs of Pyramid Lake’s endangered cui-ui fish species and its threatened Lahontan cutthroat trout, or for other federal purposes. The State of California generally requires a minimum flow of natural flow or 5 cfs, whichever is less, downstream from the dam for maintaining fish habitat.
- [6] **Stampede Reservoir** – The dam and reservoir, constructed by the USBR in 1970, drains an area of some 136 square miles and has a total capacity of 226,000 acre-feet. Water must be used primarily for spawning flows for the endangered cui-ui fish species and the threatened Lahontan cutthroat trout of Pyramid Lake. Storage space is also part of COE flood control plan. Stampede Reservoir water may be stored only after: (1) Floriston rates and Truckee River diversion rights have been satisfied; (2) Boca Reservoir is full; and (3) Independence Lake is full. Due to its relatively junior water rights, this reservoir seldom fills and therefore has been targeted as a prime storage location for Reno–Sparks municipal water as part of the Negotiated Settlement (Public Law 101–618) and the implementation of a new Truckee River Operating Agreement (TROA). The State of California requires a minimum flow of 30 cfs downstream from the dam for maintaining fish habitat (although this agreement has expired, the rates of flow have been maintained).
- [7] **Boca Reservoir** – The original Boca dam was built around 1868 for ice harvesting. The present, much larger dam, was constructed in 1937 and created a reservoir with a total capacity of 40,800 acre-feet and a drainage area, to include the entire Little Truckee River Basin (including both Independence Lake and Stampede Reservoir) of some 172 square miles. Title to stored water is held by the USBR and operated by the Washoe County Water Conservation District (WCWCD). The reservoir’s water is used in conjunction with Lake Tahoe water to maintain Floriston rates and to provide part of the required COE flood control capacity. Up to 25,000 acre-feet of water may be stored in Boca Reservoir only after Floriston rates are satisfied and Independence Lake’s first storage priority of 3,000 acre-feet is satisfied. The balance may not be filled unless the Newlands Project diversion right at Derby Dam (on the lower Truckee River) has been satisfied. SPPCo stores a small portion (800 acre-feet) of its privately owned stored water (POSW) rights here. There are no minimum downstream flow requirement associated with Boca Reservoir.
- [8] **Derby Dam/Truckee Canal/Lahontan Reservoir** – Although Lahontan Reservoir is not a storage facility of the Truckee River Basin, it does store Truckee River waters diverted at Derby Dam on the lower Truckee River. Derby Dam, which is located approximately 11 miles upstream from Wadsworth, Nevada, is the regulating device by which Truckee River waters are diverted into the Truckee Canal for use within the Truckee Division of the Newlands Project and for storage in Lahontan Reservoir in the Carson River Basin for use within the Carson Division of the Newlands Project. The dam, originally named the Truckee River Diversion Dam, was completed by the USBR in June 1905, whereas the Truckee Canal was not completed through to the Carson River until August 1906. Lahontan Reservoir was not completed until 1915, at which time the Truckee Canal’s outlet was re-routed slightly upstream so as to enter Lahontan Reservoir instead of flowing directly into the Carson River below the dam. Diversions and releases are conducted in accordance with the Truckee River Agreement, the Orr Ditch Decree, and Newlands Project OCAPs, which allow for a maximum diversion of up to 1,500 cfs (Orr Ditch Decree right, although current canal capacity is only 900 cfs) from: (a) remainder of Floriston rates and return flows from upstream diversions; (b) right to Truckee River tributary water; and (c) any water bypassed or released to obtain space to store flood waters in reservoirs if water right holder did not identify a use for the release. Under the more recent project OCAPs, the quantity of water which may be diverted from the Truckee River at Derby Dam varies with the determination of irrigation entitlement each year (water-righted acreage to be irrigated and the appropriate water duty for bench and

bottom lands) and the predicted runoff from the Carson River and water in storage in Lahontan Reservoir.

Also see *Operational Criteria and Procedures (OCAP) [Nevada]*, *Public Law 101–618 [Nevada and California]*, and *Truckee River Operating Agreement (TROA) [Nevada and California]*.

Truckee River General Electric Decree [California] — Represented the resolution, through a 1915 federal court consent decree, of a lengthy series of conflicts, litigation, and negotiations between the *U.S. Bureau of Reclamation (USBR)* and the Truckee River General Electric Company (predecessor to the present-day Sierra Pacific Power Company), which, in 1902, through a complicated series of real estate transactions had obtained title to the Lake Tahoe Dam, surrounding lands, and the hydropower plants on the Truckee River. The USBR was in desperate need of Lake Tahoe water for its Newlands Project, then nearing completion near Fallon in Churchill County. This decree granted the USBR an easement to operate the Lake Tahoe Dam and to use surrounding property owned by the power company. On its part, the USBR was required to provide certain year-round flow rates (the *Floriston Rates*), measured at a stream gage near the state line, to support hydropower generation. These rates, in fact, dated back to a 1908 river flow agreement among the Truckee River General Electric Company, the Floriston Land and Power Company, and the Floriston Pulp and Paper Company and required that “...there shall be maintained a flow of water in the said Truckee River at Floriston [California] of not less than 500 cubic feet per second from the First day of March to the 30th day of September inclusive, in each year, and of not less than 400 cubic feet per second from the 1st day of October to the last day of February, inclusive, in each year.” While this decree did dictate how the Lake Tahoe Dam would be operated, it did little to solve the concerns of residents of the lake and lessen California’s concerns over the apportionment of Lake Tahoe waters.

Truckee River Operating Agreement (TROA) [California and Nevada] — The Truckee River Operating Agreement is incorporated in Section 205 of *Public Law 101–618* (the *Negotiated Settlement*) and requires that the U.S. Secretary of the Interior negotiate an operating agreement for the Truckee River with the States of Nevada and California, and other parties. The intent of the TROA is to supplant the current *Truckee River Agreement* and provide for the comprehensive management of the Truckee River waters in California and Nevada, as well as to provide important long-term drought protection for the Reno–Sparks (Nevada) Metropolitan Area. The primary purpose of the TROA is to improve management of Truckee River reservoirs located in California by expanding existing operations for the benefit of municipal and industrial water use, increase drought storage, aid in the recovery of endangered and threatened fish species, and, in general, improve fish and wildlife habitat within the Truckee River Basin. This would be accomplished by “networking” reservoir releases and storage (i.e., unify reservoir operations for a common objective and into a single schedule) in a manner that would not infringe on existing water storage, release, and use rights or flood control requirements. The TROA would also allow for the exchange, transfer, and release of waters from the upstream reservoirs to improve the likelihood of maintaining instream flows for fish and wildlife. The TROA is intended to provide a number of substantive benefits to users of Truckee River waters. These benefits may be listed in four fundamental areas:

- [1] **Reservoir Management** – Improve river flow and river management by improving flexibility, coordinate reservoir storage and release, allow transfers and exchanges among various reservoirs to reduce spills, provide for recreational pools, etc., create a water credit system, promote more efficient use of existing water supplies, allow for the storage of “other waters”, centralize Truckee River water management, improve water accounting (budgeting) and forecasting, eliminate releases solely for power generation, permit storage of water savings from conservation in the Reno–Sparks Metropolitan Area, and provide for greater water marketing among private water rights holders;
- [2] **Fish and Wildlife** – Enhance spawning potential of the Pyramid Lake endangered cui-ui (*Chasmistes cujus*) and threatened Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) fish species through improved overall river operations, commitment of specified waters, increased water availability, and mitigation of significant adverse environmental impacts;
- [3] **Municipal and Industrial Use** – Provide additional M&I drought relief storage for the Reno–Sparks Metropolitan Area through an M&I Water Credit System;
- [4] **Conservation** – Promote water conservation in the Reno–Sparks Metropolitan Area through water metering and various conservation programs.

Truckee Storage Project [Nevada] — A U.S. Bureau of Reclamation (USBR) storage project to provide a supplemental source of irrigation water for 29,000 acres in the Truckee Meadows (Washoe County) surrounding the cities of Reno and Sparks, Nevada. Diversion and delivery of irrigation water are made by the ditch companies which form the Washoe County Water Conservation District (WCWCD).

Trunk Stream — See *Main Stream*.

TSS — See *Total Suspended Solids*.

Tsunami — (Oceanography) (1) A huge sea wave caused by a great disturbance under an ocean, as a strong earthquake or volcanic eruption. (2) A very long water wave caused by a submarine earthquake or volcanic eruption; mistakenly used as a synonym for *Tidal Wave*. (3) A long-period (usually 15–60 minutes) wave caused by a large-scale movement of the sea floor, from a volcanic eruption, submarine earthquake, or landslide. Although it may be barely noticeable at sea, its velocity may be as high as 400 knots, so that it travels great distances and in shoal water may reach heights of around 15 meters (50 feet).

TTHM — Total Trihalomethane.

Tube Settler — (1) A device using bundles of tubes to let solids in water settle to the bottom for removal by conventional sludge collection means; sometimes used in sedimentation basins and clarifiers to improve particle removal. (2) A device that uses bundles of small bore (2 to 3 inches or 50 to 75 mm) tubes installed on an incline as an aid to sedimentation. The tubes may come in a variety of shapes including circular and rectangular. As water rises within the tubes, settling solids fall to the tube surface. As the sludge (from the settled solids) in the tube gains weight, it moves down the tubes and settles to the bottom of the basin

for removal by conventional sludge collection means. Tube settlers are sometimes installed in sedimentation basins and clarifiers to improve particle removal.

Tube Well — Describes any of a variety of drilled wells which are cased. In most tube wells screening is provided in the area of aquifer penetration where water is to be withdrawn.

Tubercle — A protective crust of corrosion products (rust) which builds up over a pit caused by the loss of metal due to corrosion.

Tuberculation (Tubercules) — Development or formation of small mounds of corrosion products on the inside of iron pipe. The tubercles so formed roughen the inside of the pipe, increasing its resistance to water flow. See *Microbiological Tuberculation*.

Tufa — (Geology) The calcareous and siliceous rock deposits of springs, lakes, or groundwater. Typically consist of calcium carbonate (CaCO_3) deposits created by precipitation from supersaturated waters entering a cold lake from thermal springs. Some forms of shoreline tufa were created by an algal process in which carbon dioxide was extracted by the algae to produce insoluble calcium carbonate; this was then precipitated as aragonite (as opposed to calcite). Several primary forms of tufa have been identified:

- [1] **Lithoid** – deposited in superimposed layers, compact and stony;
- [2] **Thinolite** – made up of elongated skeletal crystals;
- [3] **Dendritic** – the most abundant variety, of branching structure;
- [4] **Cellular** – found as coatings; and
- [5] **Coralline** – occurring in heads and coatings.

Also see *Travertine*.

Tuffs — (Geology) A volcanic rock composed of ash particles.

Tulare Lake [Central Valley, California] — During the early history of the San Joaquin Valley, most of the land which was later to become Kings County was covered by a large fresh water lake, and was reportedly to have been the largest water body in the western United States. Supplied with waters brought from the Sierra Nevada mountains via the Kings, Kaweah and Tule rivers, this body of water was named Tulare Lake for the tules, or bullrushes, which grew thickly around it. The region was first visited by the Spanish in 1772, and the area covered by Tulare Lake then was estimated to have been about 50 miles (80 km) long and 35 miles (60 km) wide, or nearly 1,800 square miles. Historically, the region was of immense size and created habitats for numerous aquatic and land animals. An 1850 account told of “bands of elk, deer and antelope in such numbers that they actually darkened the plains for miles and looked in the distance like great herds of cattle.” An 1892 description reported that “The area of the lake at highest water (220 feet above sea level) was 760 square miles” and others who visited this region reported that the area surrounding Tulare Lake “abounded in game and was full of edible fish.” The tules and other grasses that grew so thickly around the lake made it an ideal habitat for ducks, geese, plover, snipe and curlew which were hunted extensively by local sportsmen. Reclamation districts were soon formed throughout the Central Valley and each district soon built levees, diversion structures, and canals which diverted ever more water flowing out of the Sierra Nevada from ever reaching Tulare Lake. By the early 1870’s, much of the water that had ended up in the lake was effectively diverted onto irrigated fields. What was once lake bottom soon became some of the richest agricultural land in the world. Still, in years of particularly high precipitation and Sierra Nevada snowpack runoff, the lowest portions of this region still fill with far more modest quantities of water just as they did for thousands of years.

Tulloch Rule [EPA] — In the 1980’s, enterprising developers began to drain and destroy wetlands without undergoing environmental review by using specialized equipment such as welded buckets and sealed containers. This equipment allowed them to limit the amount of dredged material re-deposited during ditching, mining, and channelization projects. Then, in 1993, the *Environmental Protection Agency (EPA)* and *U.S. Army Corps of Engineers (Corps)* closed the loophole by issuing the “Tulloch Rule” in response to a lawsuit settlement with the National and North Carolina Wildlife Federations. The Tulloch Rule required environmental review and *Clean Water Act (CWA) Section 404* permitting for projects that involved the redeposit of dredged material, including most wetland drainage, mining, and stream channelization activities. Subsequently, on June 19, 1998, the District of Columbia Circuit Court, in *National Mining Association v. United States Army Corps of Engineers*, affirmed a lower court’s ruling striking down the Tulloch Rule. The court’s ruling re-opened a gaping loophole that permitted sophisticated developers to destroy wetlands and streams and evade the spirit, if not the letter of the law by using specialized equipment (“Tulloch Proof”) to remove material dredged during ditching operations and deposit it off-site. In one of their final acts, the Clinton Administration finalized a rule proposed by the EPA/Corps that will help to eliminate abuses of the Tulloch loophole. It does so by creating a requirement that those intending to conduct a project in wetlands or streams come first to the Corps and seek a permit or show that their project would not result in a discharge as regulated by the CWA. The rule also describes how most mechanized activities in wetlands and streams stir up sediment that is then transported to another location and re-deposited. These kinds of re-deposits are “discharges of dredged or fill material,” regulated by the CWA.

Tundra — A type of *Ecosystem* or *Biome* dominated by lichens, mosses, grasses, and woody plants. Tundra may be found both at high latitudes (arctic tundra) and high altitudes (alpine tundra). Arctic tundra is underlain by permafrost and is usually saturated, also classifying it also as a *Wetlands*.

Tunnel Erosion — See *Piping*.

Turbellarian — The tiny eddies created in water by the cilia any of a class (*Turbellaria*) of mostly aquatic and free-living flatworms (as a planarian).

Turbid — (1) Having the lees or sediment disturbed; roiled; cloudy. (2) Not clear or translucent; clouded, muddy; dull; impure; polluted. Having a cloudy or muddy appearance. Also see *Turbidity*.

Turbidimeter — A device used to measure the degree of turbidity, or the density of suspended solids in a sample.

Turbidity — (Water Quality) (1) Thick or opaque with matter in suspension; muddy water. The cloudy appearance of water caused

by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring. (2) The cloudy appearance of water caused by the presence of suspended and colloidal matter. In the waterworks field, a turbidity measurement is used to indicate the clarity of water. Technically, turbidity is an optical property of the water based on the amount of light reflected by suspended particles. Turbidity cannot be directly equated to suspended solids because white particles reflect more light than dark-colored particles and many small particles will reflect more light than an equivalent large particle. (3) A measure of the reduced transparency of water due to suspended material which carries water quality implications. The term “turbid” is applied to waters containing suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. The turbidity may be caused by a wide variety of suspended materials, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton and other microscopic organisms and similar substances. Turbidity in water has public health implications due to the possibilities of pathogenic bacteria encased in the particles and thus escaping disinfection processes. Turbidity interferes with water treatment (filtration), and affects aquatic life. Excessive amounts of turbidity also make water aesthetically objectionable. The degree of the turbidity of water is measured by a *Turbidimeter*. (4) The collective optical properties of a water sample that cause light to be scattered and absorbed rather than transmitted in straight lines; the higher the intensity of scattered light, the higher the turbidity. Turbidity is expressed in the *Nephelometric Turbidity Unit (NTU)*, the *Jackson Turbidity Unit (JTU)*, or Formazin turbidity units (FTU) depending on the method and equipment used.

Turbidity Current — (1) A current that transports sediments along and in contact with the bottom, as in a stream or lake. (2) A current in which a limited volume of turbid or muddy water moves relative to surrounding water because of its greater density. (3) A large-volume, rapid, downslope underwater current, usually generated by a seismic disturbance, which causes a slumping of sediment on the slope and starts a flow of sediment and water. (4) (Oceanography) A dense current that carries large amounts of clay, silt, and sand through sea water that is less dense.

Turbidity Units (TU) — Turbidity units are a measure of the cloudiness of water. If measured by a nephelometric (deflected light) instrumental procedure, turbidity units are expressed in *Nephelometric Turbidity Units (NTU)* or simply TU. Those turbidity units obtained by visual methods are expressed in *Jackson Turbidity Units (JTU)* which are a measure of the cloudiness of water; they are used to indicate the clarity of water. There is no real connection between NTUs and JTUs. The Jackson turbidimeter is a visual method and the nephelometer is an instrumental method based on deflected light.

Turbine — A propeller or wheel device driven by the pressure of liquid or gas.

Turbulence — (Hydraulics) (1) The secondary motion caused by eddies in a moving flow of water. (2) A state of fluid flow in which instantaneous velocities exhibit irregular and apparently random fluctuations. (3) (Chaotic Dynamics) Another term for chaos. More specifically, a term used to describe complex evolution in space and time (referred to as fully developed turbulence), where spatially localized behavior is chaotic and behavior at spatially separated points is decreasingly correlated as the separation increases. With respect to fluids this manifests itself as vortices and eddies of all magnitudes. Although originally used to describe fluid complexity, the term is now applied to any spatiotemporal complexity of this type.

Turbulent Flow — (1) Water flow in which the flow lines are confused and heterogeneously mixed. It is typical of flow in surface-water bodies. (2) (Physics) The motion of a fluid having local velocities and pressures that fluctuate randomly. (2) The mechanism by which a fluid such as water moves near a rough surface. Fluid not in contact with the irregular boundary outruns that which is slowed by friction or deflected by the uneven surface. Fluid particles move in a series of eddies or whirls. Most stream flow is turbulent, and turbulent flow is important in both erosion and transportation. Contrast with *Laminar Flow*.

Turbulent Heat Conduction — (Oceanography) The transfer of heat within a water mass through irregular, random eddy diffusion, laterally and vertically.

Turning Basin — A widened area in a navigation channel or harbor area which is constructed to enable ships to maneuver in a safe and efficient manner.

Turnout — A structure that diverts water from an irrigation canal to a distribution system or farm delivery point. Turnouts are used at the head of *Laterals*.

Turnover — The circulation of water in deep temperate lakes to equalize the temperature throughout the water column.

Turnover, Fall — A physical phenomenon that may take place in a body of water during early autumn. The sequence of events leading to fall overturn include: (1) the cooling of surface waters; (2) a density change in surface waters producing convection currents from top to bottom; (3) the circulation of the total water volume by wind action; and (4) eventual vertical temperature equality. The overturn results in a uniformity of the physical and chemical properties of the entire water body. Also referred to as *Fall Overturn*. Also see *Spring Overturn*.

Turnover, Spring — A physical phenomenon that may take place in a lake or similar body of water during the early spring, most frequently in lakes located in temperate zones where the winter temperatures are low enough to result in freezing of the lake surface. The sequence of events leading to spring overturn include: (1) the melting of ice cover; (2) the warming of surface waters; (3) density changes in surface waters producing convection currents from top to bottom; (4) circulation of the total water volume by wind action; and (5) vertical temperature equality. The overturn results in a uniformity of the physical and chemical properties of the entire water mass. Also referred to as *Spring Overturn*. Also see *Fall Overturn*.

Tussock — (Ecology) (1) A thick, compact clump of grass or other vegetation. (2) A mound of relatively solid ground in an otherwise swampy area, formed by plant roots that have bound together.

25-Year, 24-Hour Duration Flood (Twenty-Five Year, 24-Hour Duration Flood) — The flood magnitude expected to be equaled or exceeded on the average of once in 25 years, with a four percent chance of being exceeded in any given year, determined by using the 25-year, 24-hour storm unless gauging data is available and proved to be accurate.

Two-Layer Ocean — (Oceanography) An ideal ocean model in which a surface layer of uniform density overlies a deep layer of uniformly greater density.

TWS — Transient Water System.

Typhoid Fever — An acute, highly infectious disease caused by a bacillus (*Salmonella typhi*) transmitted chiefly by contaminated food or water and characterized by high fever, headache, coughing, intestinal hemorrhaging, and rose-colored spots on the skin. Also referred to as *Enteric Fever*.

Typhoon — (1) A tropical *Cyclone* occurring in the region of the Philippines or China Sea. (2) Both typhoons and *Hurricanes* are severe tropical storms which are characterized by wind speeds exceeding 32 meters per second (150 miles per hour). The winds spiral inward toward the storm center, a characteristic typifying cyclonic flow. The winds of these storm systems rotate clockwise in the Southern Hemisphere and counterclockwise in the Northern Hemisphere. At the center of these systems there are light breezes, even the legendary “calm” of the “eye of the storm.” Barometric pressure also decreases rapidly toward the center, where record low pressures have been recorded. Wind speed, humidity, and rainfall increase toward the central zone, termed the “eye,” where wind and moisture suddenly decrease. If there exists a strong downdraft in the eye, temperatures there may also be some 8E-10E Centigrade (14E-18E Fahrenheit) higher than in the storm’s main body. Such tropical cyclones are not common. Their total number in a given year may vary from 30 to 100, with about one-quarter of those occurring near Southeast Asia, one-seventh occurring in the Caribbean and adjacent waters, and one-tenth of the total occurring in the southwest Pacific and Australian waters. They play a noticeable, if not erratic role in the general circulation of the *Atmosphere*, transporting large amounts of warm, moist air from very low to middle latitudes. It is estimated that a fully developed hurricane may export more than 3,500,000,000 tons of air per hour, thus contributing greatly to the redistribution of moisture within the *Troposphere*. The development of a hurricane involves the release of considerable amounts of energy and the transfer of substantial quantities of water over several degrees of latitude.

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U

U Tube — (Wastewater Treatment) (1) A pipe shaped like a “U” that is constructed in a force main to raise the dissolved oxygen concentration in the wastewater. (2) U-tube manometers are used to indicate the pressure of a gas or liquid in a contained area, such as a pipeline or storage vessel.

Ubac — (Ecology) The shady northern side of an alpine mountain, characterized by a lower timberline and a lower snow line than the sunny southern side.

Ubiquitous Hydrophytes — Plant species that grow either in wetland or on upland areas – e.g., red maple (*Acer rubrum*) as opposed to *Obligate Hydrophytes*, which are plant species that are found only in wetlands – e.g., cattail (*Typha latifolia*).

Ubiquitous Organisms — Organisms that can tolerate a wide range of environmental conditions or variations. Also, organisms that are so active or so numerous as to seem to be present or existent in all types of environments.

UDI — See *Groundwater Under the Direct Influence (UDI) of Surface Water*.

Udometer — A *Rain Gauge*.

UIC — Underground Injection Control.

Ultrafiltration — Filtration through a medium (as a semipermeable capillary wall) which allows small molecules (as of water) to pass but holds back larger ones (as of protein).

Ultraviolet Light Disinfection — A disinfection method for water that has received either *Secondary* or *Tertiary Treatment* used as an alternative to *Chlorination*.

Ultraviolet Radiation (UV) — Light waves shorter than the visible blue-violet waves of the spectrum, i.e., below 3900 Angstroms (D). UV can be used effectively for the disinfection of water.

Unbiased Sample — (Statistics) A sample is said to be unbiased if its behavior and characteristics are representative of the total *Population*.

Unconcentrated Flow — See *Overland Flow*.

Unconfined — Conditions in which the upper surface of the *Zone of Saturation* forms a water table under atmospheric pressure.

Unconfined Aquifer — (1) An aquifer in which the uppermost groundwater surface is at atmospheric pressure. (2) An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well. An unconfined aquifer made up of loose material, such as sand or gravel, that has not undergone lithification (settling). In an unconfined aquifer the upper boundary is the top of the *Zone of Saturation* (water table).

Unconformity Iceberg — (Oceanography) An iceberg composed of more than one kind of ice, such as water-formed ice and the more granular firn. Such an iceberg is characterized by many silt-bands and crevasses.

Unconsolidated Deposits (Sediment) — Sediment not cemented together; may consist of sand, silt, clay, and organic material.

Unconsolidated Formation — Natural earth formations that have not been turned to stone, such as alluvium, soil, gravel, clay, sand and overburden.

Unconsolidated Strata — Rocks consisting of loosely coherent or uncemented particles, whether occurring at the surface or at depth.

Uncontrolled Artesian Well — By uncontrolled artesian well is meant one that cannot be controlled by mechanical means.

Uncontrolled Spillway — A structure, usually part of a dam or other impounding device or structure, over or through which excess or flood flows are discharged solely by the elevation of the spillway crest. Contrast with *Controlled Spillway*.

Undercurrent — (1) A current, as of air or water, below another current or beneath the surface. (2) (Oceanography) A current flowing beneath a surface current, usually in the opposite direction. Sometimes it flows in the same direction as the surface current but at a different speed.

Underflow — (1) (Surface and Groundwater) The downstream flow of water through the permeable deposits underlying a stream. Groundwater flow within a streambed below a surface stream. (2) (Water Quality) The slurry of concentrated solids or *Sludge* that is removed from the bottom of a *Settling Tank*, *Clarifier*, or *Thickener*. (3) Submerged gravity-driven flows which occur when inflows to a water body are denser than the ambient water. The inflow subsequently plunges and continues as a distinct flow which can be envisioned as a submerged stream. Underflows, also called *Density Current*, are known to form intermittently on coastal continental shelves, in reservoirs and at effluent discharge sites.

Underdrain — A drain that carries away water from prepared beds or agricultural fields to which water or wastewater has been applied.

Underfit Stream — A stream that appears to be too small to have eroded the valley in which it is flowing.

Underflow Conduit — (Geology) A deposit underlying a stream channel that is permeable enough for water to pass through.

Underground Injection — A subsurface emplacement through a bored, drilled, driven or dug well where the depth is greater than the largest surface dimension, whenever a principle function of the well is the emplacement of any fluid.

Underground Injection Control (UIC) — A program required in each state by a provision of the *Safe Drinking Water Act (SDWA)* for the regulation of *Injection Wells*, including a permit system. An applicant must demonstrate that the well has no reasonable chance of adversely affecting the quality of an underground source of drinking water before a permit is issued.

Underground Source of Drinking Water (USDW) — An aquifer that is currently being used as a source of drinking water or those

potentially capable of supplying a public water system. They have a total dissolved solids content of 10,000 milligrams per liter or less, and are not *Exempted Aquifers*.

Underground Stream — A body of water having a definite current and flowing beneath the ground surface within a distinct channel.

Underground Storage and Recovery — See *Recharge*.

Underground Storage Tank — (Water Quality) (1) Any one or combination of underground tanks and any connecting underground pipes used to contain an accumulation of regulated substances. (2) A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals.

Underground Water — Water below the surface of the ground. Also referred to as *Groundwater*, *Ground Water*, *Subsurface Water*, and *Subterranean Water*.

Undermelting — The melting of any floating ice from beneath.

Understory — Plants growing beneath the canopy of other plants. Usually refers to grasses, forbs, and low shrubs under a tree or shrub overstory.

Undertow — (Oceanography) (1) The seaward return of water carried up the shore by breaking waves. (2) A supposed subsurface current near shore that pulls swimmers downward and out to sea; but actually a mistaken description of rip currents in the surf. (3) Any current moving beneath and in a different direction from surface water.

Uniformitarianism — (1) (General) The concept that the present is the key to the past. (2) (Geology) A principle stating that ancient geological events can be explained or understood in terms of the geologic processes, phenomena, and forces that occur in the present; based on the belief that current geologic processes act in the same manner and with the same intensity as they did in the past.

Uniformity Coefficient — (1) A numerical expression of the variety in particle sizes in mixed natural soils, defined as the ratio of the sieve size on which 40 percent (by weight) of the material is retained to the sieve size on which 90 percent of the material is retained. (2) The ratio of (a) the diameter of a grain (particle) of a size that is barely too large to pass through a sieve that allows 60 percent of the material (by weight) to pass through, to (b) the diameter of a grain (particle) of a size that is barely too large to pass through a sieve that allows 10 percent of the material (by weight) to pass through. The resulting ratio is a measure of the degree of uniformity in a granular material such as filter media.

$$\text{Uniformity Coefficient} = \text{Particle Diameter}_{60\%} / \text{Particle Diameter}_{10\%}$$

Unimpaired Flow — The flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modifications in land use.

Unit Density — A density of one gram per cubic centimeter or one gram per milliliter; the density of water at 4EC (39.2EF).

United States Army Corps of Engineers (COE) — See *(United States) Army Corps of Engineers (COE)*.

United States Bureau of Indian Affairs (BIA) [USDI] — See *(United States) Bureau of Indian Affairs (BIA)*.

United States Bureau of Land Management (BLM) [USDI] — See *(United States) Bureau of Land Management (BLM)*.

United States Bureau of Reclamation (USBR) [USDI] — See *(United States) Bureau of Reclamation (USBR)*.

United States Department of the Interior (USDI) — See *(United States) Department of the Interior (USDI)*.

United States Environmental Protection Agency (EPA) — See *(United States) Environmental Protection Agency (EPA)*.

United States Fish and Wildlife Service (USFWS) [USDI] — See *(United States) Fish and Wildlife Service (USFWS)*.

United States Forest Service (USFS) [USDA] — See *(United States) Forest Service (USFS)*.

United States Geological Survey (USGS) [USDI] — See *(United States) Geological Survey (USGS)*.

United States Natural Resources Conservation Service (NRCS) [USDA] — See *(United States) Natural Resources Conservation Service (NRCS)*. Formerly known as the *Soil Conservation Service (SCS)*.

United States Soil Conservation Service (SCS) [USDA] — Former name of the *(United States) Natural Resources Conservation Service (NRCS)*.

Unit Hydrograph — (1) The *Hydrograph* of direct runoff from a storm uniformly distributed over the drainage basin during a specified unit of time; the hydrograph is reduced in vertical scale to correspond to a volume of runoff from the drainage basin of one inch. (2) The hydrograph of surface runoff (not including groundwater runoff) on a given basin due to an effective rain falling for a unit of time.

Unit Period — The time duration of a unit storm. See *Unit Storm*, below.

Unit Storm — A net rainfall one-inch deep which occurs over all parts of a drainage area at a uniform rate during a specified unit period of time.

Universities Water Information Network (UWIN) — The Universities Water Information Network disseminates information of interest to the water resources community and all concerned with the nation's water resources. UWIN's mission is envisioned as helping to bring water resources to the information superhighway. UWIN is housed at the Headquarters of the Universities Council on Water Resources at Southern Illinois University in Carbondale, Illinois, and is part of their outreach efforts to the water resources community. UWIN staff encourages involvement in this process by asking for submission of articles and other research materials for posting on the Internet.

University of Florida Center for Wetlands — See *Center for Wetlands [University of Florida]*.

Unmeasured Sediment Discharge — The difference between *Total Sediment Discharge* and measured *Suspended-Sediment Discharge*.

Unravel — To loosen material from the edges of a revetment.

Unsaturated Flow — Movement of water in a porous medium in which the pore spaces are not filled with water and the direction of flow is from the wetter zone of higher potential to one of lower potential.

Unsaturated Zone — (1) The area between the land surface and water table in which the pore spaces are only partially filled with water. (2) The portion of the soil profile which contains both air and water. Water in this zone cannot enter a well. (3) The subsurface zone between the water table (*Zone of Saturation*) and the land surface where some of the spaces between the soil particles are filled with air. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water, as well as air and other gases at less than atmospheric pressure. Saturated bodies, such as *Perched Groundwater*, may exist in the unsaturated zone, and water pressure within these bodies may be greater than atmospheric. Also referred to as the *Vadoso Zone* or, less frequently, the *Zone of Aeration*.

Unsteady Flow — Flow that is changing with respect to time.

Updrift — (Oceanography) A shoreward movement of littoral material, opposite to its general seaward movement.

Upgradient Well — A groundwater monitoring well, such as those required at facilities that treat, store, or dispose of hazardous waste using surface impoundments or landfills, that allows sampling and analysis of groundwater that is upstream from the facility, before the groundwater is possibly affected by any escaping contaminants. The results of the analyses are used for comparison to the results of groundwater sampled from *Downgradient Wells*.

Uplands — (1) The ground above a floodplain; that zone sufficiently above and/or away from transported waters as to be dependent upon local precipitation for its water supplies. (2) Land which is neither a *Wetland* nor covered with water.

Uplift — (Hydraulics) The upward pressure of water on the base of a structure or the upward pressure in the pores of a material, i.e., *Interstitial Pressure*.

Upper Basin States [Colorado River Basin] — Colorado, New Mexico, Utah, and Wyoming. Also see *Colorado River Compact* and *Lower Basin States*.

Uprush — (1) (Meteorology) The abrupt upward rush of air that occurs during a rapid development of a *Cumulus Cloud*, as before a thunderstorm. Also referred to as a *Vertical Jet*. (2) (Oceanography) See *Swash*.

Upstream — (1) Toward the source of a stream. Similarly, upriver. (2) Toward the source or upper part of a stream; against the current. In relation to water rights, the term refers to water uses or locations that affect water quality or quantity of downstream water uses or locations. (3) The direction against the flow of water; or, toward or in the higher part of a sewer or collection system.

Upstream Blanket — An impervious layer placed on the reservoir floor upstream of a dam. In the case of an *Embankment Dam*, the blanket may be connected to the impermeable element of the dam.

Upstream Control — Control structure adjustments based on information from upstream. The required information is measured by a sensing device located upstream, or based on the upstream water schedule established by the watermaster.

Upstream Slope (of a Dam) — The part of the dam that is in contact with the reservoir water. On *Earthen Dams* the upstream slope must be protected from the erosive action of waves by rock *Rip Rap*, concrete, or some other material.

Uptime — (Irrigation) The total time that a system is available for service.

Upwelling — (Oceanography) (1) The movement to the surface of deep, cold, nutrient-laden water, usually caused by coastal currents that pull surface water away from the coast or by wind divergence of equatorial currents. (2) The appearance of water from the deep ocean at the surface. This usually occurs along the coasts of continents (such as the coast of Peru along the west coast of South America) where the prevailing winds tend to push the surface waters away from the land area, allowing waters from the deep ocean to rise to the surface. The deep waters carry a significant input of plant nutrients to the surface, causing an elevated level of primary production and abundant fish populations. (3) The process or an instance of rising or appearing to rise to the surface and flowing outward; especially the process of upward movement to the surface of marine often nutrient-rich lower waters particularly along some shores due to the offshore drift of surface water (as from the action of winds and the *Coriolis Effect*).

Urban and Industrial Pollution — Includes a number of synthetic pollutants that are the byproducts of urban living, as well as industrial production and agricultural activities. Urban pollution is derived from leaking gas tanks and sewers, industrial waste discharges, commercial facilities, failed septic systems, leaking sewer lines, and old and current landfills and unprotected and unlined dump sites. For example, see *Chlorofluorocarbons (CFC)*, *Dibromochloropropane (DBCP)*, *Dichloro-Diphenyl-Trichloroethane (DDT)*, *Methyl Tertiary Butyl Ether (MTBE)*, *Non-Point Source (NPS) Pollution*, *Polychlorinated Biphenyls (PCB)*, *Polychlorinated Naphthalenes (PCN)*, *Polycyclic Aromatic Hydrocarbons (PAH)*, *Polynuclear Aromatic Hydrocarbons (PNA)*, *Primary Amoebic Meningoencephalitis (PAM)*, *Synthetic Organic Chemical/Compound (SOC)*, *Total Trihalomethane (TTHM)*, *Trichloroethane/Trichloroethylene (TCE)*, *Trihalomethane (THM)*, *Volatile Organic Chemical (VOC)*.

Urban and/or Small Stream Flood Advisory — An advisory issued by the *National Weather Service (NWS)* when localized flooding which is an inconvenience or nuisance (not life threatening) to people living in the affected area. This includes flooding of streets and roads, urban storm drains, low-lying areas and small creeks and streams.

Urban Equilibrium (of a Channel) — A term used to describe a channel that has changed from its natural or original shape but has finished adjusting to the urban influences affecting it so that it is relatively stable in its planeform and meander and has achieved a new balanced in its bankfull width and depth, so that it is neither excessively eroding nor depositing and has healthy riparian growth.

Urban Flooding — Nuisance flooding of streets, underpasses, basements and other low-lying urban areas. Should not be confused with flash flooding. Usually due to poor drainage, or limited drainage capacity of urban systems. The amount and rate of precipitation that causes urban or *Small Stream Flooding* is usually constant for a specific community. In general, 0.5-1.0 inch (1.3-2.5 cm) of precipitation in one hour will cause at least minor urban/small stream flooding in most urbanized areas. Over one inch of rainfall in an hour will cause general urban flood problems, and may cause flash flooding.

Urban Geology — The application of geology to problems in the urban environment.

Urban Runoff — Storm water from city streets and gutters that usually contains a great deal of litter and organic and bacterial wastes

into the sewer systems and receiving waters.

Urban Water Use — The use of water for urban purposes, including residential, commercial, industrial, recreation, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

Urban Water Use per Capita — A unit of water use which encompasses all urban uses of water in a service area. Generally measured in gallons per capita per day (gpcd).

Usable Groundwater [EPA] — The *U.S. Environmental Protection Agency (EPA)* recognizes that “usable” groundwater may serve a variety of purposes. Common purposes of groundwater include, for example, drinking water, agricultural irrigation, car washes, and manufacturing. Groundwater also has less formally acknowledged purposes such as replenishing adjacent aquifers or surface water bodies.

Usable Storage Capacity — The available storage capacity plus the remaining groundwater storage within a reasonable pump lift. Specific yield of the sediments is used in calculating estimates of usable storage capacity.

Use (Water) — This term, when referring specifically to water use, is normally preceded by one of the following descriptive terms:

- [1] **Conjunction Water** — The integrated use of surface and subsurface water supplies and facilities, normally involving storage of surplus waters when available, for use during periods when water supplies are deficient.
- [2] **Consumptive Water** — The quantity of water discharged to the atmosphere or incorporated in the products in the process of vegetative growth, food processing, industrial processes, or other uses.
- [3] **Consumption Irrigation** — The quantity of water that is absorbed by the crop and transpired or used directly in the building of plant tissue together with that evaporated from the cropped area.
- [4] **Multiple** — The conscientious management of the various renewable resources such as water, wood, forage, wildlife, and recreation resources, to obtain sustained yield of products and services in the combination that will best meet the needs of the public now and in the future.

Also see *Consumptive Use* and *Nonconsumptive Use*.

User Fee — A fee which is collected only from those persons who use a particular service, as opposed to one collected from the public in general. User fees generally vary in proportion to the degree of use of the service.

USGS — See *United States Geological Survey*.

USGS (Test-Well) Site Identification — The standard *U.S. Geological Survey (USGS)* site identification is based on the grid system of latitude and longitude. The number consists of 15 digits. The first six digits denote the degrees, minutes, and seconds of latitude; the next seven digits denote degrees, minutes, and seconds of longitude; and the last two digits (assigned sequentially) identify the sites within a 1-second grid. For example, site 365227114554401 is at 36E52N270 latitude and 114E55N440 longitude, and it is the first site recorded in that 1-second grid. The assigned number is retained as a permanent identifier even if a more precise latitude and longitude are later determined. Also see *Local (Test-Well) Site Designation [Nevada]*.

U-Shaped Valleys — U-shaped valleys are characteristic of glacial erosion; valleys eroded by stream action are typically *V-Shaped*. Also referred to as *Glaciated Valleys*.

USTs — Underground Storage Tanks.

Usufruct, also Usufructuary — (Legal–Civil Law) The right of enjoying a thing, the property of which is vested in another, and to draw from the same all the profit, utility, and advantage which it may produce, provided it be without altering the substance of the thing. For example, in Nevada, the state’s water belongs to the people, but is permitted, through the water rights permitting process, to be used beneficially by other individuals or entities.

Usufructuary (Water) Right — (1) A right to use rather than own the property of another, such as the state’s water. (2) A water right holder’s authority to divert and use a certain amount of water. See *Usufruct*.

Utility — (Engineering) A municipal or regional facility such as a water works, power plant, or telephone system.

Utility Water Use — Water supplied from a *Public Water Supply System* and used for such purposes as firefighting, street washing, and municipal parks and swimming pools. Public water use also includes system water losses (water lost to leakage) and brine water discharged from desalination facilities. Also referred to as *Public Water Use*.

UV — Ultra-Violet. See *Ultraviolet Radiation*.

V

V-Shaped Valleys — Valleys typically eroded by stream action. *U-Shaped Valleys*, by contrast, are characteristic of glacial erosion.

Vacuum Drying — Removal of liquid material from a solution or mixture under reduced air pressure, which results in drying at a lower temperature than is required at full pressure.

Vacuum Filtration — (Water Quality) A process by which liquid is extracted from a sludge. The filtrate is forced through a filtering material by means of a vacuum.

Vacuum Relief Valve — A device that automatically relieves or breaks vacuum in an irrigation pipeline or conduit due to system failure or shutdown.

Vadose — Of, relating to, or being water that is located in the *Zone of Aeration* in the earth's crust above the groundwater level.

Vadose Zone — (1) The zone containing water under pressure less than that of the atmosphere, including soil water, intermediate vadose water, and capillary water. This zone is limited above by the land surface and below by the surface of the *Zone of Saturation*, that is, the water table. (2) The subsurface zone between the water table (zone of saturation) and the land surface where some of the spaces between the soil particles are filled with air. (3) The zone of soil or ground material between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water as well as air and other gases at less than atmospheric pressure. Also referred to as the *Unsaturated Zone* or, less frequently, the *Zone of Aeration*.

Vadose Water — Water occurring in the *Unsaturated Zone (Vadose Zone)* between the land surface and the water table.

Vale — A valley, often coursed by a stream; a dale.

Valley — (1) An area of land that is lower than the land on either side of it. (2) An elongated depression cut by stream erosion and associated water erosion on its sideslopes (stream valley). Also used in the vernacular for *Intermontane* and *Intramontane Basins*. Also see *U-Shaped Valleys* and *V-Shaped Valleys*.

Valley Braid — See *Anabranch*.

Valley Deposits — See *Valley Sediment Deposits*.

Valley Fill — Alluvium or other material occupying areas below mountain slopes.

Valley Glacier — See *Alpine Glacier*.

Valley Line — (Geology) See *Thalweg*.

Valley Sediment Deposits — The genesis of valley deposits is closely intertwined with the history and morphology of the stream which formed (i.e., deposited) them. Stream channel deposits are primarily transitory accumulations of bed load particles which move downstream spasmodically, typically at long intervals, and are at rest on the stream bed most of the time. All valley deposits are subject to repeated erosion, transportation, and redeposition, hence making them transitory in a geologic sense. However, those within existing stream channels are much less stable than overbank valley deposits. While the characteristics of such deposits are complex and difficult to explain, like the river system that formed them, a genetic classification of the various kinds of deposits, their genesis, and the relationships between them provides important information in water planning investigations. This is especially true when attempting to estimate the probable behavior of a stream that is being modified by man-made works, such as dams, diversions, and other regulating and modifying structures. The listing below provides the characteristics of the principal genetic types of fluvial sediments organized by their place of deposition within a valley system.

- [1] **Channel Deposition** — (a) Transitory channel deposits: consist of primarily bed load temporarily at rest; part may be preserved in more durable channel fills or lateral accretions; (b) Lag deposits: consist of the segregation of larger or heavier particles, more persistent than transitory channel deposits, and includes heavy mineral placers; (c) Channel fills: consist of accumulations in abandoned or aggrading channel segments; ranging from relatively coarse bed load to fine-grained oxbow lake deposits.
- [2] **Channel Margin Deposition** — Lateral accretion deposits: consist of point and marginal bars that may be preserved by channel shifting and added to the overbank floodplain by vertical accretion deposits at the top.
- [3] **Overbank Floodplain Deposition** — (a) Vertical accretion deposits: consist of fine-grained sediment deposited from suspended load of overbank flood water; includes natural levee and backland (backswamp) deposits; (b) Splays: consist of local accumulations of bed load materials which are spread from channels on to adjacent floodplains.
- [4] **Valley Margin Deposition** — (a) Colluvium: consists of deposits that are derived chiefly from unconcentrated slope wash and soil creep on adjacent valley sides; (b) Mass movement deposits: consist of earthflow, debris avalanche, and landslide deposits commonly intermixed with marginal colluvium; mudflows usually follow channels but also spill overbank.

Valley-Side Moraine — See *Lateral Moraine*.

Valve — A device fitted to a pipeline or orifice in which the closure member is either rotated or moved transversely or longitudinally in the waterway so as to control or stop the flow.

Vapor — The gaseous state of a substance which under ordinary conditions exists as a liquid or solid.

Vapor Barrier — A continuous plastic membrane which surrounds the entire thermal envelope of a house and prevents moisture

penetration into the wall cavity. Also referred to as a *Vapor Retarder*.

Vapor Blanket — The layer of air which overlies a body of water and, due to its proximity to the water, has a water vapor content higher than that of the surrounding atmosphere.

Vapor Flow — The gaseous flow of water vapor in soils from a moist or warm zone of higher potential to a drier or colder zone of lower potential.

Vaporization — The change of a substance from a liquid or solid state to the gaseous state.

Vapor Concentration — See *Absolute Humidity*.

Vapor Density — See *Absolute Humidity*.

Vapor Plumes — Flue gases visible because they contain water droplets.

Vapor Pressure — The partial pressure of water vapor in the atmosphere.

Vapor Trail — A visible trail of streaks of condensed water vapor or ice crystals sometimes forming in the wake of an aircraft. Also referred to as *Contrail*.

Variable — (Statistics) A series of comparable observations or characteristics of a phenomenon taken as a single set of data; a listing of specific characteristics of a population or a number of observations taken over a specific period of time which may reasonably be expected to vary from observation to observation.

Variable Source Area — The flexible zone adjacent to and extending the stream that contributes runoff to the channel during a runoff-producing event.

Variance — (Water Quality) State or U.S. Environmental Protection Agency (EPA) permission not to meet a certain drinking water standard. The water system must prove that: (a) it cannot meet a *Maximum Contaminant Level (MCL)*, even while using the best available treatment method, because of the characteristics of the raw water; and (b) the variance will not create an unreasonable risk to public health. The state or EPA must review, and allow public comment on, a variance every three years. States can also grant variances to water systems that serve small populations and which prove that they are unable to afford the required treatment, an alternative water source, or otherwise comply with the standard. Also see *Exemption*.

Variance (σ^2) — (Statistics) A measure of the spread or dispersion of a variable about its *Mean* or *Arithmetic Mean* value. The variance is calculated by taking the sum of the squares of the deviations, that is, the sum of the difference between the observed value and the series mean value, and dividing by the sample size (number of observations). The variance for a large data set (the population variance) is calculated as:

$$\sigma^2 = \sum (x_i - \bar{x})^2 / n$$

where:

x_i is an individual observation;

$\bar{x}$ is the mean of all observations; and

n is the number of observations.

For smaller data sets (typically less than 50) the sample variance (s^2) is calculated by replacing n with $(n - 1)$ in this equation. The positive square root of the variance is called the *Standard Deviation*. Both the variance and the standard deviation are non-negative, by definition.

Varve — (Geology) (1) A layer or series of layers of sediment deposited in a body of still water in one year. (2) A regular, annual layer of silt or clay deposited in a glacier-fed lake within one year's time. (3) A sedimentary layer or sequence of layers, consisting of coarser and finer materials deposited within a glacial meltwater lake or other body of still water during one year's time. (4) A pair of layers of alternately finer and coarser silt or clay believed to comprise an annual cycle of deposition in a body of still water.

Vascular Plant — Any of various plants, such as the ferns and seed-bearing plants, in which the phloem transports sugar and the xylem transports water and salts.

Vector — An insect or other organism that carries and transmits a pathogenic amoeba, bacterium, fungus, virus, or worm.

Vegetated Buffer — A vegetated upland or wetland area next to rivers, streams, lakes, or other open waters which separates the open water from developed areas, including agricultural land. Vegetated buffers provide a variety of aquatic habitat functions and values (e.g., aquatic habitat for fish and other aquatic organisms, moderation of water temperature changes, and detritus for aquatic food webs) and help improve or maintain local water quality. A vegetated buffer can be established by maintaining an existing vegetated area or planting native trees, shrubs, and herbaceous plants on land next to open waters. Mowed lawns are not considered vegetated buffers because they provide little or no aquatic habitat functions and values. The establishment and maintenance of vegetated buffers is a method of compensatory mitigation that can be used in conjunction with the restoration, creation, enhancement, or preservation of aquatic habitats to ensure that activities authorized by NWP's result in minimal adverse effects to the aquatic environment.

Vegetated Shallow — Vegetated shallows are special aquatic sites under the *Clean Water Act* 404(b)(1) Guidelines. They are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as sea grasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems.

Vegetation Management — The practice of manipulating the species mix, age, fuel load, and distribution of wildland plant communities within a prescribed management area. It includes prescribed burning, grazing, chemical applications, biomass harvesting, and any other economically feasible methods of enhancing, retarding, or removing the above-ground parts of plants.

Vegetative Controls — *Non-Point Source (NPS) Pollution* control practices that involve vegetative cover to reduce erosion and minimize loss of pollutants.

Velocimeter — A device for measuring the speed of sound in water.

Velocity, Average Interstitial (v) — The average rate of ground-water flow in interstices, expressed as the product of *Hydraulic Conductivity* and *Hydraulic Gradient* divided by the *Effective Porosity*. It is synonymous with *Average Linear Ground-Water Velocity* or *Effective Velocity*.

Velocity Head — (1) Energy contained by fluid because of its velocity; usually expressed in feet of fluid (foot-pounds per pound). (2) The energy in flowing water as determined by a vertical height (in feet or meters) equal to the square of the velocity of flowing water divided by twice the acceleration due to gravity ($V^2/2g$).

Velocity (of Water in a Stream) — Rate of motion of a stream measured in terms of the distance its water travels in a unit of time, usually expressed in feet per second.

Vena Contracta — The minimum cross section of a jet of fluid discharging from an orifice or over a weir.

Vent — An air release valve or stand used to release air trapped at high points in a pipeline.

Venturi — A short tube with a constricted throat used to determine fluid pressures and velocities by measurement of differential pressures generated at the throat as a fluid traverses the tube.

Venturi Effect — The increase in the velocity of a fluid stream as it passes through a constriction in a channel, pipe, or duct. Calculated by the *Continuity Equation*, or

$$Q = VA$$

where:

Q is the volumetric flow rate;

A is the area of flow; and

V is the fluid velocity.

Because Q does not change, as A gets smaller then V must increase.

Venturi Flume — A calibrated measuring flume having a contracted throat section which produces a differential head that can be related to discharge.

Venturi Meter — (1) A meter, developed by Clemens Herschel, for measuring flow of water or other fluids through closed conduits or pipes. It consists of a venturi tube and one of several forms of flow registering devices. (2) A flow measuring device placed in a pipe. The device consists of a tube whose diameter gradually decreases to a throat and then gradually expands to the diameter of the pipe. The flow is determined on the basis of the difference in pressure (caused by different velocity heads) between the entrance and throat of the Venturi meter. Of note is that most Venturi meters have pressure sensing taps rather than a *Manometer* to measure the pressure difference. The upstream tap is the high pressure tap or side of the manometer.

Venturi Scrubbers — Air pollution control devices that use water to remove particulate matter from emissions.

Venturi Tube — A closed conduit that gradually contracts to a throat, causing a pressure head by which the velocity through the throat may be determined.

Verglas — A thin coating of ice, as on rock.

Vernal Pool — (1) A *Wetland* that occurs in shallow basins that are generally underlain by an impervious subsoil layer (e.g., a clay pan or hard pan) or bedrock outcrop, which produces a seasonally perched water table. (2) A type of *Wetland* in which water is present for only part of the year, usually during the wet or rainy seasons (e.g., spring). Also referred to as *Temporary Wetland*. (3) (Ecology) A temporary pool of water formed during a spring thaw. Vernal pools are seasonally flooded depressions found on ancient soils with an impermeable layer such as a hardpan, claypan, or volcanic basalt. The impermeable layer allows the pools to retain water much longer than the surrounding uplands. Even so, the pools are shallow enough to dry up each season. Vernal pools often fill and empty several times during the rainy season. Only plants and animals that are adapted to this cycle of wetting and drying can survive in vernal pools over time. Vernal pools and other wetlands collect water, moderating seasonal flooding during storm events. Wetlands, including vernal pools also remove contaminants from the water, including agricultural and urban runoff.

Vertical Accretion Deposits — In valley sediment deposition, vertical accretion deposits consist of fine-grained sediment deposited from suspended load of overbank flood water; including natural levee and backland (backswamp) deposits. See *Valley Sediment Deposits*.

Vertical Closed-Loop System — A continuous length of sealed pipe that is installed in one or more drill holes for the purpose of utilizing geothermal heat.

Vertical Separation Distance — (Water Quality) A phrase used to describe the distance between the bottom of a sewage septic system's drain field and the underlying water table. The separation distance allows *Pathogens* (disease-causing bacteria, viruses, or protozoa) in the effluent to be removed by the soil before it comes in contact with the groundwater. Many different factors can affect pathogen removal and directly impact the separation distance needed for removal, including temperature, seasonal high groundwater tables, groundwater mounding, and soil type.

Vertical-Velocity Curve — A curve showing how the down-gradient velocity varies with depth along a vertical depth-observation line in a surface stream.

Vessel — (1) A hollow utensil, such as a cup, vase, or pitcher, used as a container, especially for liquids. (2) (Nautical) A craft, especially one larger than a rowboat, designed to navigate on water.

Vessel Sewage Discharge Program [EPA] — See *Clean Water Act (CWA) Section 312 [EPA]*.

Vested Rights — The term "vested rights" most typically means: (1) The right of a riparian owner to continue to use water actually applied to any beneficial use; (2) Use for domestic purposes; (3) The right of a riparian owner to take and use water for beneficial

purposes if the riparian owner was engaged in the construction of works for the actual application of the water to a beneficial use, provided the works were completed and water was applied to use within a reasonable time thereafter. Also see *Vested Water Right*.

Vested Water Right — (1) The water right to use either surface or groundwater acquired through more or less continual beneficial use prior to the enactment of water law pertaining to the source of the water. These claims become final through *Adjudication*. (2) A fully executed or finalized appropriate right to use the waters of a state for a beneficial purpose. Also see *Certificated Water Right* and *Perfected Water Right*.

Vibrio Comma — The waterborne microorganism which causes asiatic cholera.

Vicariance — (Biology) The separation or division of a group of organisms by a geographic barrier, such as a mountain or a body of water, resulting in differentiation of the original group into new varieties or species.

Vichy Water — (1) A naturally effervescent mineral water originally from the springs at Vichy, France. (2) A sparkling mineral water resembling this effervescent beverage.

Violation [EPA] — (Water Quality) A failure to meet any state or federal drinking water regulation.

Virga — streaks or wisps of precipitation falling from a cloud but evaporating before reaching the ground.

Virgin Flow — (1) The streamflow which exists or would exist if man had not modified the conditions on or along the stream or in the drainage basin. (2) A stream flow that is not affected by any artificial influences, such as dams, reservoirs, or other constructions.

Virus — (1) Very small disease-causing microorganisms that are too small to be seen even with microscopes. Viruses cannot multiply or produce disease outside of a living cell. (2) The smallest form of microorganisms capable of causing disease. Viruses infectious to humans can be transmitted through contaminated water (especially viruses of fecal origin). (3) Any of a group of submicroscopic infective agents causing important diseases in plants and animals. They may be living organisms or complex protein molecules capable of growth and multiplication only in living cells. (4) The smallest (10-300 μm in diameter) life form capable of producing infection or diseases in man or other larger species. Complex macromolecules which are able to reproduce themselves only in living cells and are capable of producing infection and diseases.

Viscosity (η) — (1) A property of water, or any other fluid, which resists efforts to change its shape or flow. Syrup is more viscous (has a higher viscosity) than water. The viscosity of water increases significantly as temperatures decrease. Motor oil is rated by how thick (viscous) it is; 20 weight oil is considered relatively thin while 50 weight oil is relatively thick or viscous. (2) A measure of the resistance of a fluid to flow. For liquids, viscosity increases with decreasing temperature. For gases, viscosity increases with increasing temperature. Expressed as mass per length-time (e.g., kilograms per meter-second). A common viscosity unit is the *Poise*. One poise equals 1.0 gram per centimeter-second. Also referred to as *Dynamic Viscosity*.

Viscous — See *Viscosity*.

Visibility — Broadly, the distance to which an observer can distinguish objects from their background. The concept may apply to both air and water. The determinants of visibility include the characteristics of the target object (shape, size, color, pattern), the angle and intensity of sunlight, the observer's eyesight, and the extent of light absorption and scattering caused by air and water contaminants.

Visual Resource — The composite of basic terrain, geologic features, hydrologic features, vegetative patterns, and land use effects that typify a land unit and influence the visual appeal that the unit may have for visitors.

Visual Resource Management (VRM) — The VRM system is an analytical process that identifies, sets, and meets objectives for maintaining the visual quality of public lands. The system is based on research that has identified ways to assess aesthetic qualities of the landscape and public concern for these qualities.

VOC — See *Volatile Organic Carbon (VOC)*.

VOCs — See *Volatile Organic Chemicals (VOCs)*.

Void — The pore space or other openings in rock. The openings can be very small to cave size and are filled with water below the *Water Table*.

Void Ratio — Ratio of volume of intergranular voids to volume of solid material in a sediment or sedimentary rock.

Voids — A general term for pore spaces or other openings in rock.

Volatile — (1) Readily vaporizable at a relatively low temperature. (2) Describes a substance that evaporates or vaporizes rapidly at room temperature, as a volatile liquid.

Volatile Acids — Acids produced during digestion. Fatty acids which are soluble in water and can be steam-distilled at atmospheric pressure. Also called *Organic Acids*. Volatile acids are commonly reported as equivalent to acetic acid.

Volatile Liquids — Liquids which easily vaporize or evaporate at room temperatures.

Volatile Organic Carbon (VOC) — (Water Quality) A measure of the amount of particulate material in a water sample that is lost upon heating. The measure is obtained by passing a given quantity of water through a glass fiber filter and then drying and weighing the solids retained on the filter. The pre-weighed filter is then heated to about 500–600°C (930–1,100°F) and a second weight is obtained. The amount lost during the heating process is termed VOC.

Volatile Organic Chemicals (VOCs) — (1) Solvents used as degreasers or cleaning agents which sometimes contaminate water, particularly groundwater. Improper disposal of VOCs can lead to contamination of natural waters. VOCs tend to evaporate very easily. This characteristic gives VOCs very distinct chemical odors like gasoline, kerosene, lighter fluid, or dry cleaning fluid. Some VOCs are suspected cancer-causing agents. (2) These are chemicals of an organic nature (containing hydrogen, oxygen, and carbon) which readily volatilize, or travel from the water into the air. Most such substances are industrial chemicals and solvents. They include light alcohols, acetone, trichloroethylene, perchloroethylene, dichloroethylene, benzene, vinyl chloride, toluene, and methylene chloride. These potentially toxic chemicals are used as solvents, degreasers, paints, thinners, and fuels. Because of their volatile nature, they readily evaporate into the air, increasing the potential exposure to humans. Due to their

low water solubility, environmental persistence, and widespread industrial use, they are commonly found in soil and water. The U.S. Environmental Protection Agency (EPA) maintains a listing of VOCs that are regulated with respect to *Maximum Contaminant Levels (MCLs)* as part of the *Safe Drinking Water Act (SDWA)*. Also referred to as *Volatile Organic Compounds (VOCs)*.

Volatile Organic Compounds (VOCs) — Organic compounds that can be isolated from the water phase of a sample by purging the water sample with inert gas, such as helium, and subsequently analyzed by gas chromatography. Many VOCs are manmade chemicals that are used and produced in the manufacture of paints, adhesives, petroleum products, pharmaceuticals, and refrigerants. They are often components of fuels, solvents, hydraulic fluids, paint thinners, and dry cleaning agents commonly used in urban settings. VOC contamination of drinking-water supplies is a human health concern because many are toxic and are known or suspected human carcinogens. Also referred to as *Volatile Organic Chemicals (VOCs)*.

Volatile Solids — The quantity of solids in a sample which is lost by ignition of the dry solids at 600EC.

Volatility — A measure of the tendency of a *Solvent* or other material to evaporate at normal temperatures.

Volatilization — The process by which a substance is passed off as vapor; *Evaporation*.

Volcanic Rock Aquifer — An aquifer composed of rock that originated from a volcano, such as basalt. This type of rock may or may not be very permeable.

Volcanic Water — (Volcanology) (1) Magmatic water that is on or just under the earth's surface. (2) *Juvenile Water* (new water) furnished by lava flows and volcanic activity.

Volume Transport — (Oceanography) The amount of water that a current transports between two points of reference, expressed in cubic meters per second; determined by multiplying the current speed times the cross-sectional areal limits of the current.

Volumetric — A measurement based on the volume of some factor. Volumetric titration is a means of measuring unknown concentrations of water quality indicators in a sample by determining the volume of titrant or liquid reagent needed to complete particular reactions.

Volumetric Flow Rate — For a liquid or a gas, the volume moving past a point per unit time. The actual flow rate (Q) may be expressed as

$$Q = AV$$

where A is the cross-sectional area of the pipe or conduit and V is the velocity of the liquid or gas.

Volumetric Tank Test — One of several tests to determine the physical integrity of a storage tank; the volume of fluid in the tank is measured directly or calculated from product-level changes. A marked drop in volume indicates a leak.

Volumetric Water Content — That portion of the volume of a soil sample that is occupied by water, expressed as percent by volume.

Vortex — (1) A revolving mass of water which forms a *Whirlpool*. This whirlpool is caused by water flowing out of a small opening in the bottom of a basin or reservoir. A funnel-shaped opening is created downward from the water surface. (2) A spiral motion of fluid within a limited area, especially a whirling mass of water or air that sucks everything near it toward its center.

Vortex Rocks — Rocks placed in a streambed to help direct flows for the formation of meanders and creation of riffles and pools. The rocks are so named for their ability to contribute to sediment transport through the channel.

Vulnerability Assessment [EPA] — (Water Quality) (1) An evaluation of drinking water source quality and its vulnerability to contamination by pathogens and toxic chemicals. (2) An evaluation which shows that contaminants of concern either have not been used in a watershed area or the source of water for the system is not susceptible to contamination. Susceptibility is based on prior occurrence, vulnerability assessment results, environmental persistence and transport of the contaminants, and any wellhead protection program results.

W

Wade — To walk in or through water or something else that similarly impedes normal movement.

Wadi, also Wady — (Geology) (1) A ravine or watercourse, dry except in the rainy season and some are permanently dry. Also see *Arroyo*. (2) A channel or steep-sided valley or ravine in certain desert regions that carries water only during the rainy season. Also spelled *Wady* and *Waddy*. (3) The intermittent stream that flows through such a channel.

Waft — (1) To cause to go gently and smoothly through the air or over water. (2) To convey or send floating through the air or over water.

Wake — The visible track of turbulence left by something moving through water.

Walker Lake [Nevada] — A desert lake located at the terminus of the Walker River in western Nevada. Walker Lake (along with *Pyramid Lake* to the north) represents one of only two remaining major lake remnants of ancient *Lake Lahontan*, an Ice Age lake which covered approximately 8,655 square miles of northwestern Nevada as recently as 12,500 years ago during that late *Pleistocene Epoch*. Walker Lake is approximately 13 miles long, just over five miles wide, about 90 feet deep, and contains just over two million acre-feet of water. Walker Lake's waters are of relatively poor quality, characterized by high concentrations of *Total Dissolved Solids (TDS)*, consisting mostly of salts, relatively high water temperatures, low dissolved oxygen levels, and the presence of hydrogen sulfide. Walker Lake also tends to support large blooms of planktonic blue-green algae, which, when combined with high TDS concentrations and low dissolved oxygen, creates a relatively inhospitable aquatic environment to fish species, particularly the native Lahontan cutthroat trout. Except where the Walker River enters Walker Lake at its northern end, Walker Lake's shores are virtually devoid of major riparian plant growth due, no doubt, to highly variable lake levels. In this respect, Walker Lake's barren shoreline resembles the other classic *Great Basin* desert terminal lakes (e.g., *Pyramid Lake* in Nevada, *Mono Lake* in California, and the *Great Salt Lake* in Utah). The *U.S. Geologic Survey (USGS)* has estimated that Walker Lake may expect to receive an average of 14,000 acre-feet per year of lake surface precipitation (4.9 inches per year), 11,000 acre-feet per year of local groundwater inflows, and 3,000 acre-feet per year of local surface water inflows. Flows into the lake from the Walker River, the lake's primary tributary stream, have been significantly reduced due to upstream agricultural diversions, principally in Mason Valley and Smith Valley in Nevada, and Bridgeport Valley in California. More than off-setting these inflows into Walker Lake, however, has been a relatively high rate of lake surface evaporation, totaling approximately 137,000 acre-feet per year (4.1 feet per year), thereby producing a typical average year water budget deficit for Walker Lake of approximately 33,000 acre-feet per year. As long as this water budget deficit exists (i.e., lake surface evaporation has typically exceeded average lake inflows), Walker Lake will continue to shrink and TDS concentrations will continue to increase. TDS concentrations within Walker Lake now stand at over 13,000 milligrams per liter (mg/l, or parts per million, ppm), a TDS concentration level well above the Walker River as it enters the lake (approximately 100-500 mg/l, depending on the rate of inflow). One recent USGS study measured TDS concentrations within Walker Lake at approximately 13,400 mg/l (ppm), consisting primarily of sodium chloride, dissolved carbon, and sulfate. In terms of the ionic concentrations found within Walker Lake, sodium amounts to 4,100 mg/l (31 percent by volume), chloride amounts to 3,200 mg/l (24 percent), sulfate amounts to 3,000 mg/l (22 percent), bicarbonate amounts to 2,400 mg/l (18 percent), and carbonate amounts to 670 mg/l (5 percent). The lake does host a viable population of the Lahontan tui chub fish species, which serves as a food source for the Walker Lake's Lahontan cutthroat trout population. The tui chub also provides a food source for certain migratory waterfowl, particularly the Common Loon and the White Pelican. Other native fish species in Walker Lake include the Tahoe sucker and the Lahontan redbreast. While high TDS levels have seriously stressed indigenous fish species, and completely killed off non-native (exotic) fish species introduced into Walker Lake, the lake has proven to be an extremely hospitable environment for algae growth. Unfortunately, this growth in algae, and its subsequent decomposition and oxygen depletion in the lower, cooler lake waters, has further degraded the lake's potential as a viable fishery, particularly for the native trout species. Since initial lake recordings were taken by I.C. Russell in 1882, Walker Lake's surface elevation has declined by some 134 feet, from approximately 4,080 feet above mean sea level (MSL) to 3,946 feet MSL more recently. This has resulted in a decline in the lake's depth from 224 feet recorded in 1882 to only approximately 90 feet at the present time. Today, Walker Lake is only 50 percent of its 1882 surface area and 28 percent of its 1882 volume. The decline in Walker Lake's volume from an estimated nine million acre-feet in 1882 to just over two million acre-feet by 1996 has produced the most pronounced effects on the lake's water quality. Primarily as a result of this dramatic reduction in volume, Walker Lake's concentration of total dissolved solids has risen from 2,560 milligrams per liter (mg/l) reported by Russell in 1882 to over 13,000 mg/l presently. Primary contributors to Walker Lake's salt content have been the re-dissolution of salts found in lakebed sediment layers, a groundwater inflow component, and inflows from the Walker River.

(Final) Walker River Decree [Nevada] — See *Decree C-125 (Final Walker River Decree)* [Nevada].

(Interim) Walker River Decree [Nevada] — See *Decree 731 (Interim Walker River Decree)* [Nevada].

Walker River Irrigation District (WRID) [Nevada] — The litigation of *Pacific Live Stock Company v. Antelope Valley Land and Cattle Company* and the issuance of *Decree 731* caused a number of farmers in Smith and Mason valleys to band together in April 1919 and form the Walker River Irrigation District (WRID). WRID included all irrigated areas in Nevada on the East Walker River, the West Walker River, and the main Walker River, except those areas within the Walker River Indian Reservation. WRID

moved to obtain the financing and rights to both Bridgeport and Topaz reservoir sites, sites which had earlier been selected and surveyed by the *U.S. Reclamation Service* (USRS, currently the *U.S. Bureau of Reclamation*, USBR). The water rights for Topaz Reservoir were obtained from the liquidation of the Antelope Valley Land and Cattle Company. Although WRID was established as a Nevada agency serving lands entirely within Nevada, its reservoirs would be located either entirely in California (Bridgeport Reservoir) or partially in California and Nevada (Topaz Reservoir). Funding for dam and reservoir construction and operation was obtained privately with water recipients obligated to pay off the debt. Initial funding was held down as WRID assumed no responsibility for the construction or maintenance of irrigation canals, ditches, or laterals.

Wall Cloud — A local often abrupt lowering from a rain-free cloud base. Wall clouds can range from a fraction of a mile up to nearly five miles in diameter, and are normally found on the south or southwest side of a thunderstorm. Rotating wall clouds usually develop before strong or violent tornadoes by anywhere from a few minutes up to nearly an hour.

Wall-Sided Glacier — A glacier on a steep slope, usually unconfined laterally by valley walls.

Wallow — A pool of water or mud where animals go to wallow; the depression, pool, or pit produced by wallowing animals.

Warm Front — The interface between an advancing mass of air that is warmer than the one it is replacing, usually at the point of contact with the ground surface.

Warm Spring — (1) Any spring whose water temperature is significantly above the environmental temperature of its locale, but below human body temperature. A spring that brings warm water to the surface. (2) A *Thermal Spring* whose temperatures typically are 15EF (9.5EC) or more above the mean air temperature. Compare to *Hot Spring*.

Warm-Water Sphere — (Oceanography) a general term for the warm (generally over 8EC), upper layers of the ocean in middle and low latitudes; also called, by analogy with the atmosphere, the *Ocean Troposphere*, whereas the *Cold-Water Sphere* is also called the *Ocean Stratosphere*.

(Weather) Warning [NWS] — A product issued by the *National Weather Service (NWS)* indicating that the associated condition (e.g., tornado, winter storm, flash flood, severe thunderstorm, etc.) is imminent or occurring and implies that these conditions are life threatening and/or a serious threat to property and immediate action is necessary for people in the warned area. Also see *Advisory (NWS)* and *Watch (NWS)*. Some of the more common weather warnings issued by the NWS include:

- [1] **Flash Flood Warning** — Issued when the rapid flooding of streams, creeks or urban areas is imminent or occurring. A warning implies these conditions are life threatening and immediate action is necessary for people in the warned area. The warning may result from excessive rainfall, an ice jam, a dam break or levee failure (including on a mainstem river) or a combination of these elements;
- [2] **Flood Warning** — Issued when the height of water on streams is or is forecast to reach at or above flood stage, but in a period of time too long to be considered a *Flash Flood Warning*. A warning implies these conditions are life threatening and action is necessary for people in the warned area. See also *River Flood Warning*.
- [3] **Heavy Snow Warning** — Issued when snowfall of 6 inches (15 cm) or more in 12 hours or 8 inches (20 cm) or more in 24 hours is imminent or occurring. These criteria are specific for the Midwest and may vary regionally;
- [4] **High Wind Warning** — Issued when sustained winds of 40 mph (18 meters/second) or greater are expected for 1 hour or longer or gusts of 58 mph (26 meters/second) or greater are expected for any duration. These criteria are specific for the Midwest and may vary regionally;
- [5] **Ice Storm Warning** — Issued when damaging accumulations of ice make travel extremely dangerous are imminent or occurring. Significant ice accumulations are usually ¼-inch (0.64 cm) or greater and include sleet (ice pellet) accumulations of ½-inch (1.2 cm) or more;
- [6] **River Flood Warning** — Issued when the height of water on a mainstem river is or is forecast to reach or exceed flood stage.
- [7] **Severe Thunderstorm Warning** — Issued when a severe thunderstorm is indicated by Doppler radar or reported by storm spotters. Warnings typically cover all or parts of one or a few counties. A warning means seek immediate shelter if you are in or near the warned area.
- [8] **Sleet Warning** — Issued when an accumulation of sleet of ½-inch (1.2 cm) or more is imminent or occurring;
- [9] **Tornado Warning** — Issued when a tornado is indicated by Doppler radar or sighted by storm spotters. Warnings typically cover all or parts of one or a few counties. A warning means seek immediate shelter if you are in or near the warned area;
- [10] **Wind Chill Warning** — Issued when wind chill factors of -50EF (-46EC) or colder with wind speeds of 10 mph (4.5 meters/second) or greater are imminent or occurring; and
- [11] **Winter Storm Warning** — Issued when heavy snow (6 inches (15 cm) in 12 hours or 8 inches (20 cm) in 24 hours and considerable blowing and drifting), blizzard conditions (sustained wind speeds or frequent gusts of 35 mph (16 meters/second) or higher, considerable falling and/or blowing snow reducing visibilities to less than ¼-mile, and low temperatures) and/or significant accumulations of freezing rain or sleet (greater than ¼-inch) are imminent or occurring. These criteria are specific for the Midwestern United States and may vary regionally.

Warning Stage — (1) The elevation of a river at which it is necessary to issue flood warnings if adequate precautions are to be taken. (2) The *Stage* (or *Gage Height*) at which a general state of readiness must be maintained by concerned river interests in the event of further rises above *Flood Stage* (similar to a *Watch*). In some cases, initial action must be taken by concerned interests, such as livestock and equipment removal from the lowest overflow areas. This level may produce overbank flows sufficient to cause minor flooding of low-lying areas and local roads.

WAS — See *Waste Activated Sludge*.

Wash — (1) To apply water or another liquid, as in cleaning. (2) To carry, erode, remove, or destroy by the action of moving water.

To be carried away, removed, or drawn by the action of water. Removal or erosion of soil by the action of moving water. (3) Low or marshy ground washed by tidal waters. A stretch of shallow water. (4) An area of land that is intermittently washed over by a sea or river. (5) (Western United States) The dry bed of a stream, particularly a watercourse associated with an alluvial fan, stream, or river channel. Washes are often associated with arid environments and are characterized by large, high energy discharges with high bed-material load transport. Washes are often intermittent and their beds sparsely vegetated. Also referred to as a *Dry Wash* or *Washout*. (5) Loose or eroded surface material (such as gravel, sand, silt) collected, transported, and deposited by running water, as on the lower slopes of a mountain range, especially coarse *Alluvium*. (6) Turbulence in air or water caused by the motion or action of an oar, propeller, jet, or airfoil.

Wash Load — (1) In a stream system, the relatively fine material in near-permanent suspension which is transported entirely through the system without deposition. (Geology) (2) The part of a total stream load that is composed of fine particles derived from bank erosion or some source upstream. (3) A suspended load.

Washoe Project [Nevada] — Operated by the U.S. Bureau of Reclamation (USBR), the project provides flood control, hydroelectric power, and fishery and wildlife enhancement on the Truckee River. Principal features of the project include Prosser Creek Dam and Reservoir, Stampeded Dam and Reservoir, Stampede Power Plant, Marble Bluff Dam, and the Pyramid Lake Fishway.

Washoff — Materials transported from a land or soil surface by overland flow, often used to describe soil materials transported off runoff test plots.

Washout — (1) Erosion of a relatively soft surface, such as a roadbed, by a sudden gush of water, as from a downpour or floods. (2) A channel produced by such erosion.

Washover — (Geology) (1) The sedimentary material deposited by wave overwash, especially a small delta produced by storm waves on the landward side of a barrier. Also referred to as *Storm Delta* or *Wave Delta*. 2. The process by which a washover is formed.

Waste Activated Sludge (WAS) — (Wastewater Treatment) The excess growth of microorganisms which must be removed from the process to keep the biological system in balance.

Waste Pipe — A pipe that carries off liquid waste.

Waste Treatment Lagoon — An impoundment made by excavation or earth fill for biological treatment of wastewater. Also see *Constructed Wetland* and *Lagoon*.

Waste Treatment Plant — A facility containing a series of tanks, screens, filters and other processes by which pollutants are removed from water. More commonly referred to as *Wastewater Treatment Plant*.

Wasteline Vent — (Wastewater Treatment) Most plumbing codes require a vent pipe connection of adequate size and located downstream of a trap in a building wastewater system. This vent prevents the accumulation of gases or odors and is usually piped through the roof and out of doors.

Wasteload Allocation (WLA) — A system designed to limit the total discharge of pollutant materials into a receiving body of water. Each *Point Source (PS)* of pollutants is allowed to release a specific fraction of the total amount of pollutant materials that can be expected to be assimilated by the stream. Pollution from *Non-Point Sources (NPS)* comprises the stream's *Load Allocation*.

Wastewater — (Wastewater Treatment) (1) Water that has been previously used by a municipality, industry or agriculture and has suffered a loss of quality as a result. (2) The used water and solids from a community (including used water from industrial processes) that flow to a treatment plant. Storm water, surface water, and groundwater infiltration also may be included in the wastewater that enters a wastewater treatment plant. The term "sewage" usually refers to household wastes, but this word is being replaced by the term "wastewater". (3) A combination of liquid and water-carried pollutants from homes, businesses, industries, or farms; a mixture of water and dissolved or suspended solids. (4) That water for which, because of quality, quantity, or time of occurrence, disposal is more economical than use at the time and point of its occurrence. Waste water to one user may be a desirable supply to the same or another user at a different location. Also referred to as *Domestic Wastewater*.

Wastewater Collection System — The pipe system for collecting and carrying wastewater from domestic and industrial sources to a wastewater treatment plant.

Wastewater Facilities — The pipes, conduits, structures, equipment, and processes required to collect, convey, and treat domestic and industrial wastes, and dispose of the effluent and sludge.

Wastewater Infrastructure — The plant or network for the collection, treatment, and disposal of sewage in a community. The level of treatment will depend on the size of the community, the type of discharges, and the designated use of the receiving water.

Wastewater Operations and Maintenance — Actions taken after the construction of a *Wastewater Treatment Plant* to assure that the facilities will be operated, maintained, and managed to reach prescribed effluent levels in an optimum manner.

Wastewater Reclamation — (1) The planned reuse of waste water for specific beneficial purposes. (2) Treatment and management of municipal, industrial or agricultural wastewater to produce water of suitable quality for additional beneficial uses.

Wastewater System Components — Septic tank, aerobic system, vault privy, holding tank, sewer lines of tightly jointed tile or equivalent material, or non-conventional systems.

Wastewater Treatment — Any of the mechanical or chemical processes used to modify the quality of waste water in order to make it more compatible or acceptable to man and his environment.

Wastewater Treatment Plant — (1) A water pollution control plant. (2) A water effluent treatment facility containing a series of tanks, screens, filters and other mechanical, biological, and chemical processes by which pollutants are removed from water. (3) A facility that receives wastewaters (and sometimes runoff) from domestic and/or industrial sources, and by a combination of physical, chemical, and biological processes reduces (treats) the wastewaters to less harmful byproducts; known by the acronyms, STP (sewage treatment plant), and POTW (publicly owned treatment works). Less frequently referred to as *Waste Treatment Plant*.

Wasteway — (1) Channel for conveying or discharging excess water or wastewater. (2) (Irrigation) Structure used to divert surplus

flow from the main canal into a natural or constructed drainage channel.

Waste Utilization — Using an agricultural or other waste on land in an environmentally acceptable manner while maintaining or improving soil and plant resources.

(Weather) Watch [NWS] — A product issued by the *National Weather Service (NWS)* indicating that the associated condition (e.g. tornado, winter storm, flash flood, etc.) is possible. The watch provides lead time for affected persons or agencies to prepare for the potential event. Also see *Advisory (NWS)* and *Warning (NWS)*. Some of the more common weather watches issued by the NWS include:

- [1] **Flash Flood Watch** — Issued when flash flooding is possible in and close to the watch area. A watch is used to provide advance notification that warnings may later be issued;
- [2] **Severe Thunderstorm Watch** — Issued when conditions are favorable for the development of severe thunderstorms in and close to the watch area. Watches typically cover areas on the order of a whole or parts of a few states. A watch is used to provide advanced notice that warnings may later be issued;
- [3] **Tornado Watch** — Issued when conditions are favorable for the development of tornadoes in and close to the watch area. Watches typically cover areas on the order of a whole or parts of a few states. A watch is used to provide an advance notice that warnings may later be issued; and
- [4] **Winter Storm Watch** — Issued usually 24 to 48 hours in advance when conditions are favorable for the development of hazardous weather elements such as heavy snow (for example, 6 inches (15 cm) in 12 hours or 8 inches (20 cm) in 24 hours), blizzard conditions (sustained wind speeds or frequent gusts of 35 mph (16 meters/second) or higher, considerable falling and/or blowing snow reducing visibilities to less than ¼-mile, and low temperatures) or significant accumulations of freezing rain and sleet (greater than ¼-inch). These criteria are specific for the Midwestern United States and may vary regionally.

Water (H₂O) — The liquid that descends from the clouds in rain and which forms streams, lakes, and seas, and is a major constituent of all living matter. Pure water consists of *Hydrogen* (11.188 percent by weight) and *Oxygen* (88.812 percent by weight) in the proportion of two atoms of hydrogen to one of oxygen (H₂O), and is an odorless, tasteless, transparent liquid which is very slightly compressible. It has a slightly blue color which is observable only in thick layers of the liquid. At its maximum density, 39.2EF (or 4EC), it is the standard for specific gravities, one cubic centimeter weighing one gram. Water's weight per gallon (at 15EC or 59EF) is 8.337 pounds (3.772 kilograms). It is also the standard for specific heats. Its own specific heat is very great. It freezes at 32EF (0EC) and boils at 212EF (100EC) under atmospheric pressure at sea level. Pure water is an extremely poor conductor of electric current, although many *Aqueous* (water-based) solutions are conductors. Water is the most important of solvents, dissolving many gases, liquids, and solids. Natural waters of the earth, as those of springs, rivers, or the oceans, contain more or less dissolved matter, which is mostly removed by distillation. Rain water is nearly pure. Water is important chemically as a solvent and dissociating agent, as a catalytic agent, and often as one of the substances taking part in a chemical reaction. Ordinary water, described above, is a mixture of molecules containing hydrogen of atomic weight 1, with a small proportion (about 0.015 per cent) of molecules containing hydrogen of atomic weight 2. This latter kind of water, termed *Heavy Water* or *Deuterium Oxide*, D₂O, can be separated by fractional electrolysis or distillation and in other ways and is used as a moderator in certain nuclear reactors.

Water — (1) To pour or sprinkle on, make wet. (2) To dilute or weaken by adding water. (3) To irrigate land. (4) To take on a supply of water, as a ship. (5) To drink water, as an animal. (6) Any of various forms of water, for example, fresh water, waste water, etc.; often waters, as naturally occurring mineral water, such as those at a spa. (7) A body of water such as a sea, lake, river, or stream; waters, as a particular stretch of sea or ocean, especially that of a state or country, for example, U.S. waters.

Water Administration — A broad term referring to the collective role of defined state agencies to implement state and federal water laws, commonly through the development and implementation of appropriate statutes and regulations. This role can include oversight, approval, and enforcement responsibilities.

Water Alliances For Voluntary Efficiency (WAVE) — A water conservation program conceived by the *U.S. Environmental Protection Agency (EPA)* in December 1992 and designed to help increase water efficiency in U.S. lodging facilities. The program encourages participating hotels to install water efficient technologies for bathroom fixtures, dish washing and laundry facilities, cooling towers, and landscaping. The program's goal is to reduce water use and associated energy consumption, help inform hotel guests and employees about the importance of water conservation, and help hotels realize a monetary savings for their efforts. Program components consist of technical assistance, research material availability, computer software programs to survey water use and evaluate options, and public recognition of participation. Currently more than 100 businesses and organizations participate in WAVE. The American Hotel and Motel Association has endorsed the program as both economically and environmentally beneficial to its members. For a traveler interested in choosing responsible ecodestinations, tours, and accommodations, the WAVE designation indicates that a hotel or motel:

- [1] protects the environment by conserving water resources and natural habitats;
- [2] conserves energy through water and energy efficient heating, pumping and wastewater treatment;
- [3] reduces costs and saves money through regular maintenance practices and efficient water and energy use; and
- [4] attracts environmentally conscious customers by demonstrating strong environmental stewardship.

Water Allocation — In a hydrologic system in which there are multiple uses or demands for water, the process of measuring a specific amount of water devoted to a given purpose or use.

Water Analysis — The determination of the physical, chemical, and biological characteristics of water. Such analysis usually involves four kinds of examination: bacterial, chemical, microscopic, and physical.

Water Application Efficiency — The ratio of the volume of water stored in the root zone of a soil during irrigation to the volume

of water applied.

Water Audit — (1) A procedure that combines flow measurements and listening surveys (leak detection) in an attempt to give a reasonably accurate accounting of all water entering and leaving a system. (2) A thorough examination of the accuracy of water agency records or accounts (volumes of water) and system control equipment. Water managers can use audits to determine their water distribution system efficiency. The overall goal is to identify and verify water and revenue losses in a water system.

Water Balance — (1) A measure of the amount of water entering and the amount of water leaving a system. Also referred to as *Hydrologic Budget*. Also see *Hydrologic Equation*. (2) The ratio between the water assimilated into the body and that lost from the body; also, the condition of the body when this ratio approximates unity.

Water Ballet — A synchronized sequence of movements performed by a group of swimmers.

Water Bank — A mechanism for holding water for eventual use. A water bank may include the use of surface water reservoirs, underground storage facilities (e.g., groundwater recharge), or a combination of these mechanisms.

Water Banking — A water conservation and use optimization system whereby water is reallocated for current use or stored for later use. Water banking may be a means of handling surplus water resources and may involve aquifer recharge or similar means of storage. Typically, under such arrangements, an agency is created with the authority to purchase, sell, hold, and transfer water and water rights in addition to serving as a negotiator between buyers and sellers. In its broadest sense, all water rights would be covered under such water banking arrangements to include surface water, groundwater, treated wastewater effluent, and irrigation tailwater. Generally, participants in water banking arrangements will have their water rights protected from cancellation (non-beneficial use) for a specific period so long as their water is “deposited” in the water bank. Also see *Water Marketing*.

Water-Based Recreation — Those activities which require water for participation such as boating, swimming, sailing and canoeing.

Water-Bearing Strata — (Geology) A sedimentary formation lying directly below the standing water level, so that it contains or yields water. Also see *Aquifer*.

Water Bloom — An accumulation of algae and especially of blue-green algae at or near the surface of a body of water. Also referred to as *Algal Bloom*.

Water, Bottled — See *Bottled Water*.

Water Budget — (1) An accounting of the inflows to, the outflows from, and the storage changes of water in a hydrologic unit or system. Also see *Water Balance*. For example, a typical water budget, or a *Hydrologic Balance*, for a lake or other body of water would take on the form of

$$\text{Inflows} = \text{Outflows} \pm \text{Change in Storage}$$

and detailing more specifically the inflows and outflows yields the following expression:

$$I_{\text{SW}} + I_{\text{GW}} + P_{\text{S}} = O_{\text{SW}} + E_{\text{S}} \pm \Delta S$$

where the elements of inflow are:

I_{SW} = the lake's surface water inflow from tributary streams;

I_{GW} = the lake's groundwater inflow; and

P = the lake's surface precipitation.

The elements of outflow are:

O_{SW} = the lake's surface water outflow into a river or other outlet; and

E = the lake's surface evaporation.

Therefore, ΔS represents the change in the lake's storage associated with the water budget period and balances all inflows with outflows. (2) A summation of inputs, outputs, and net changes to a particular water resource system over a fixed period. Also referred to as a *Water Balance Model*. (3) An accounting device to maintain a constant inventory of the soil or surface moisture conditions of any given area on the earth's surface. Deductions are made from the inventory in accordance with the computed evaporation and transpiration losses, and additions are made as precipitation occurs or water is added artificially or naturally from an external source. (4) (Conservation and Planning) The calculated amount of water a household should use based on the type and number of fixtures, landscape requirements, and size of family.

Water/Cement Ratio — The gallons of mixing water used for each sack of cement.

Water Classification — The separation of water in an area into classes according to usage, such as domestic consumption, fisheries, recreation, industrial, agricultural, navigation, power production, waste disposal, etc. Also see *Water Use, Types*.

Water Clock — The water clock, or *Clepsydra*, has been reliably dated to 1600 BC in Egypt. It functioned by water dripping through a hole in the base of a container, which lowered the water level past markings on the container sides. These markings were spaced to indicate fixed periods of time. Many variations were based on this design. Ctesibius of Alexandria made a clepsydra in which a figure floating on the water surface pointed to the time scale. In another type, dripping water turned a wheel that was connected to pointers on a dial face similar to a modern clock. Before the third century BC the clepsydra was used by the Greeks to indicate intervals of time, especially in law court; later it functioned as a clock. Clepsydras were later used in Rome, the Arab world, and China.

Water Color — One of the most immediately apparent attributes of many natural waters and one that, together with visual clarity, strongly influences human aesthetic perception and recreational use. Color of waters is a guide to their composition, and remote sensing of water color is increasingly being used to infer water quality, particularly suspended solids and phytoplankton

concentrations. The color of water, with water considered a translucent (i.e., not transparent) material, is commonly associated with transmitted light, for example, the color seen by a diver beneath the water's surface. However, the color of natural waters as observed from above is that associated with the upwelling light field that results from back scattering of sunlight illuminating the water volume. In this manner, the color of natural waters can be objectively specified using their spectral *Reflectance*, where the reflectance is defined as the ratio of the upwelling light to incident (downwelling) light.

Water Column — A hypothetical cylinder of water from the surface to the bottom of a stream, lake, or ocean within which the physical and/or chemical properties can be measured.

Water Commissioner — A person whose job is to make sure the water of each stream under his or her control is distributed in proper quantities at the right times to those who are authorized to receive it. Also referred to as *Ditch Rider* or *Mayordomo*. May be elected or hired by local water users or appointed by a state authority such as the state engineer or a judge.

Water Commitment — A commitment from a water purveyor to provide water service to a particular parcel of land and/or a specific development.

Water Conservation — (1) The physical control, protection, management, and use of water resources in such a way as to maintain crop, grazing, and forest lands, vegetative cover, wildlife, and wildlife habitat for maximum sustained benefits to people, agriculture, industry, commerce, and other segments of the national economy. Water conservation measures result in a reduction in applied water due to more efficient water use such as the implementation of *Best Management Practices (BMP) – Urban Water Use*, or *Efficient Water Management Practices (EWMP) – Agricultural Water Use*. The extent to which these actions actually create a savings in water supply depends on how they affect new water use and depletion. (2) (Ecology) The process or methods of protecting water resources through efficient development and management policies, including the application of technology.

Water Conserving Irrigation System — Irrigation systems including a combination of drip irrigation, soaker hoses, bubblers, and low-trajectory spray heads for water distribution; zoning irrigation for different water-demand plant types; electronic timers with five-day programming and rain override devices, irrigation schedules for early morning watering every five to seven days; and soil moisture sensors.

Water Consumed — See *Consumptive Use*.

Water Contaminants — (1) In a broad sense any physical, chemical, biological, or radiological substance or matter in the environment. (2) (Environmental) An undesirable substance not normally present, or an unusually high concentration of a naturally occurring substance, in water, soil, or other environmental medium. (3) (Water Quality) In more restricted usage, a substance in water of public health or welfare concern. Also, an undesirable substance not normally present, or an unusually high concentration of a naturally-occurring substance, in water, soil, or other environmental medium. The following table presents a listing of water contaminants, health effects, and possible sources.

Contaminant	Health Effects	Sources
Total coliform	Not necessarily disease-causing themselves, coliforms can be indicators of organisms that can cause gastroenteric infections, dysentery, hepatitis, typhoid fever, cholera, and others. Also, coliforms interfere with disinfection.	Human and animal fecal matter
Turbidity	Interferes with disinfection	Erosion, runoff, discharges
<i>Giardia lamblia</i>	Giardiasis (stomach cramps, intestinal distress)	Human and animal fecal matter
Enteric viruses	Gastroenteritis (intestinal distress)	Human and animal fecal matter
<i>Legionella</i>	Legionnaires' disease (pneumonia), Pontiac Fever	Water aerosols such as vegetable misters
Arsenic	Dermal and nervous system toxicity effects	Geological, pesticide residues, industrial wastes, smelter operations
Barium	Circulatory system effects	Geological, pesticide residues, industrial wastes, smelter operations
Cadmium	Kidney effects	Geological, mining, and smelting
Chromium	Liver and kidney effects	Geological, mining, and smelting
Fluoride	Skeletal damage	Geological, additive to drinking water, toothpaste, foods process with fluoridated water
Lead	Central and peripheral nervous system damage, kidney effects, highly toxic to infants and pregnant women	Leaches from lead pipe and lead-based solder pipe joints
Mercury	Central nervous system disorders, kidney effects	Used in manufacture of paint, paper, vinyl chloride and fungicides. Geological

Contaminant	Health Effects	Sources
Nitrate	Methemoglobinemia (blue baby syndrome)	Fertilizer, sewage, feedlots, geological
Selenium	Gastrointestinal effects	Geological, mining
Silver	Skin discoloration (argyria)	Geological, mining
Endrin	Nervous system/kidney effects	Insecticide used on cotton, small grains, orchards (canceled)
Lindane	Nervous system/liver effects	Insecticide used on seed and soil treatments, foliage application, wood protection
Methoxychlor	Nervous system/kidney effects	Insecticide used on fruit trees, vegetables
Toxaphene	Cancer risk (potentially carcinogenic)	Insecticide used on cotton, corn, grains
2,4-D	Liver/kidney effects	Herbicide used to control broad-leaf weeds in agriculture, used on forests, range, pastures, and aquatic environments
2,4,5-TP	Liver/kidney effects	Herbicide, canceled in 1984
Benzene	Cancer (carcinogen)	Fuel (leaking tanks), solvent commonly used in manufacture of industrial chemicals, pharmaceuticals, pesticides, paints, and plastics
Carbon tetrachloride	Cancer risk (potentially carcinogenic)	Common in cleaning agents, industrial wastes from manufacture of coolants
1,2-dichloroethane	Cancer risk (potentially carcinogenic)	Used in manufacture of insecticides, gasoline
Trichloroethylene	Cancer risk (potentially carcinogenic)	Waste from disposal of dry cleaning materials, and manufacture of pesticides, paints, waxes and varnishes, paint stripper, metal degreaser
Para-dichlorobenzene	Cancer risk (potentially carcinogenic)	Used in insecticides, moth balls, air deodorizers
1,1-dichloroethylene	Liver/kidney effects	Used in manufacture of plastics, dyes, perfumes, paints, synthetic organic chemicals (SOCs)
1,1,1-trichloroethane	Nervous system effects	Used in manufacture of food wrappings, synthetic fibers
Vinyl chloride	Cancer (carcinogen)	Industrial waste from manufacture of plastics and synthetic rubber
Gross alpha	Cancer (carcinogen)	Radioactive waste, uranium deposits
Radium 226 & 228	Bone cancer (carcinogen)	Radioactive waste, geological
Gross beta	Cancer (carcinogen)	Radioactive waste, uranium deposits

Water Contamination — Impairment of water quality to a degree which reduces the usability of the water for ordinary purposes, or which creates a hazard to public health through poisoning or spread of disease.

Water Content — The quantity of water present within a porous sediment or sedimentary rock, expressed as the ratio of the weight of water in the sediment to the weight of the sediment when dried. Also see *Free-Water Content*.

Water Content of Snow — The amount of liquid water contained in a snowpack. Also referred to as the *Snow Water Equivalent (SWE)* and is measured in inches of water.

Water Control — (Soil and Water Conservation) The physical control of water by such measures as conservation practices on land, channel improvements, and installation of structures for water retardation and sediment detention. As defined, this concept does not refer to the legal control of water rights.

Water-Cooled Reactor — A nuclear reactor that employs water to cool the reactor core. A nuclear reactor is a device designed to

promote the fission of an appropriate fuel (such as uranium-235) in a controlled manner. The heat produced during the fission event must be removed from the device to prevent an excessive buildup. Water is usually used as the heat transfer agent. Other coolants used in nuclear reactors of other designs are liquid sodium and inert gases. Also see *Light Water Reactor (LWR)*.

Water Crossing — A commonly used route for crossing a river or stream.

Water Cupola — (Volcanology) A bulge in the surface of the ocean directly above an underwater volcanic explosion.

Water Cushion — A pool of water maintained to absorb the impact of water flowing from an overfall structure.

Water Cycle — (1) The cycle of evaporation and condensation that controls the distribution of the earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water. (2) The process in which water evaporated from rivers, lakes, and oceans rises and condenses into clouds, and then falls back to earth as rain, hail, sleet, or snow. This process also includes transpiration from plants, groundwater movement, and runoff into rivers, streams and the ocean. Also referred to as the *Hydrologic Cycle*.

Water Data Table — The upper surface of the *Saturated Zone* that determines the water level in a well in an *Unconfined Aquifer*.

Water Dating — To date groundwater, scientists determine how much of an isotope (such as carbon-14) is still present. An isotope is an element, such as carbon or chlorine, with one or more extra neutrons in its nucleus. By knowing the precise rate of decay of a radioactive isotope, scientists can then determine how long the water has been in the soil or an aquifer. Dating is also accomplished by analyzing the concentration of isotopes like carbon-14 and chlorine-36 in the groundwater, since such concentrations have varied over time due to changes in the earth's magnetic field. Scientists can also determine when a particular sample of groundwater fell as rainwater based upon the ratio of simple hydrogen (H^1) to its isotope, deuterium (H^2). The presence of deuterium is strongly influenced by the atmospheric temperature; during colder periods, for example, the last glacial period, rainfall contained less deuterium than today.

Water Dedications — A controversial water rights policy that involves a trade-off in which a user can begin pumping groundwater in exchange for a guarantee to buy and retire a like amount of surface water in the future. Critics of the policy argue that dedications are often difficult to enforce and can lead to overuse of groundwater when a user fails to fulfill on the guarantee.

Water Delivery System — Reservoirs, canals, ditches, pumps, and other facilities to move water.

Water Demand — The water requirements for a particular purpose, such as irrigation, power production, municipal supply, plant transpiration, or storage.

Water Demand Schedule — A time distribution of the demand for prescribed quantities of water for specified purposes. It is usually a monthly tabulation of the total quantity of water that a particular water user intends to use during a specified year.

Water Desalination — The removal of salts, such as from a saline water supply, usually by *Electrodialysis* or *Reverse Osmosis*.

Water Dilution Volume (WDV) — The volume of water required to dilute radioactive waste to a concentration meeting drinking water standards. Typically expressed in cubic meters of water per metric ton of radioactive waste.

Water Discharge — The amount of water and sediment flowing in a channel, expressed as volume per unit of time. The water contains both dissolved solids (*Dissolved Load*) and suspended sediment (*Suspended Load*).

Water Discipline — Consuming water that has been properly treated, conserving and protecting the potable water supply, and ensuring that potable water does not become contaminated from careless or improper handling.

Water Disposal System — The complete system for removing excess water from land with minimum erosion. For sloping land, this may encompass a terrace system, terrace outlet channels, dams, and grassed waterways. For level land, it may include only surface drains or both surface and subsurface drains.

Water Distribution System — A system of piping, valves, storage tanks, pumps, and appurtenances by which water is conveyed for domestic or municipal use by a common distribution system, including a municipality, a nonprofit rural water supply company, a water user district, a sanitary district, or homes, including mobile homes and manufactured homes supplied by a common distribution system.

Water Duty — The total volume of irrigation water required to mature a particular type of crop. In stating the duty, the crop, and usually the location of the land in question, as well as the type of soil, should be specified. It also includes consumptive use, evaporation and seepage from on-farm ditches and canals, and the water that is eventually returned to streams by percolation and surface runoff. Also see *Alpine Decree [California and Nevada]*, *Orr Ditch Decree [California and Nevada]*, *Bench Lands [Nevada]*, and *Bottom Lands [Nevada]*, for additional information and examples of specific water duties.

Water Duty [Nevada] — The *Alpine Decree* and *Orr Ditch Decree* provide the basis for virtually all irrigation water duties relating to water diversions from the Truckee, Carson, and Walker rivers in Northern Nevada. These decrees provide for an annual maximum irrigation duty of 4.5 acre-feet per acre for water-righted *Bench Lands* and 3.5 acre-feet per acre for water-righted *Bottom Lands* delivered to farm headgates. These duties are based on the *Crop Water Requirement* on the irrigation of alfalfa, as it is the most prominent crop and the highest water-using crop grown in the *Newlands (Irrigation) Project* in west-central Nevada. However, neither decree identifies lands as to bottom or bench. This has created considerable controversy, particularly within the Newlands Project, which constitutes a principal water user of both Carson River waters and Truckee River (diverted) waters. Also see *Alpine Decree [California and Nevada]*, *Orr Ditch Decree [Nevada and California]*, *Bench Lands [Nevada]*, and *Bottom Lands [Nevada]*.

Water Education For Teachers (Project WET) [Nevada] — A statewide supplementary, interdisciplinary water education program with components for the education community (K–12) and the general public. The goal of *Nevada Project WET* is to facilitate and promote the awareness, appreciation, knowledge, and stewardship of Nevada's water resources through the development and dissemination of classroom ready teaching aides, teacher training, learning materials, and demonstration models as well as the maintenance of a resource bureau. The program is designed to provide useful, unbiased information in a straight-forward, neutral fashion addressing a wide variety of water-related topics to include: atmospheric water, surface water, groundwater, water conservation, water pollution, water laws, water users, and competition for limited water resources. The International Office for

Water Education (IOWE) was established at Utah State University in 1983 to promote water/science education. The *U.S. Geological Survey (USGS)* National Water Information Clearinghouse (NWIC) has been established to serve as a focus for the dissemination of water resource information to all levels of government, academia, the private sector, and the general public. National Project WET at Montana State University coordinates the individual state WET programs. The *Nevada Division of Water Planning (Department of Conservation and Natural Resources)*, along with the Nevada Cooperative Extension, National Project WET, and the International Office for Water Education sponsor the Nevada Project WET program for the State of Nevada.

Water Education Foundation (WEF) [Sacramento, California] — The Water Education Foundation is an impartial, non-profit organization whose mission is to create a better understanding of water issues and help resolve water resource problems through education and awareness programs. In addition to a full-time staff of educators, researchers, and writers, the WEF is governed by a volunteer board of 25 members representing a broad cross-section of the water, education, business, environmental, and public interest communities. The WEF offers a variety of programs to teach students about one of the world's most critical issues: water. The Foundation's various programs teach students about the history, geography, and science of water. Students also learn about the difficult political and policy decisions surrounding complex water issues. Foundation programs are suitable for students in grades K-14. In addition, the WEF serves as the California coordinator for the national Project WET (Water Education for Teachers) K-12 program. The Foundation's tours offer participants a firsthand look at the water facilities, rivers, and regions critical in the debate about the future of water resources in California and the West. Issues of water supply, water quality, environmental restoration, flood management, water marketing, and water conservation are addressed by a wide range of speakers representing different viewpoints. Participants learn about local, state, and federal issues from a host of experts on all sides of water issues. Annual Executive Briefings feature leaders from stakeholder groups, the State Legislature, and government agencies with a role in making policy decisions about water. Representatives from the urban, business, farming, environmental, and public interest sectors discuss and debate their viewpoints on current water issues at this one-day briefing. Panel presentations on such topics as water marketing, the Bay-Delta, CALFED, the Colorado River, drinking water, groundwater, floods and drought, water ballot measures and legislative proposals, the Central Valley Project Improvement Act, the Endangered Species Act, water quality, and more allow participants to hear the latest on these vital water-related issues. WEF products include: (1) maps and posters; (2) videos and slide shows; (3) school programs; (4) Colorado River materials; (5) Layperson's Guides; (6) games and models; (7) *Western Water Magazine*; (8) water awareness materials; (9) cards and stickers; and (10) other publications.

Water Environment Federation (WEF) — The Water Environment Federation's vision is to be the preeminent organization dedicated to the preservation and enhancement of the global water environment. The mission of the WEF is to deliver high quality products and services to members and stakeholders; promote and advance the water quality industry; and benefit society through protection and enhancement of the global water environment. The WEF's strategic initiative is to be the leading source of information and knowledge on the water environment and it intends to accomplish this through the following objectives: (1) identify and segment targeted memberships and audiences; (2) develop a more comprehensive understanding of and approach to the total water environment; (3) adapt and tailor products and services to targeted audiences and membership; (4) optimize the use of leading edge information technology; (5) proactively pursue synergistic relationships with other water-related organizations and associations throughout the world; (6) proactively seek to participate in government processes in order to assure mutually beneficial, technically and environmentally sound and defensible outcomes; (7) seek and institute collaborative ventures with selected private enterprise organizations; and (8) provide technical leadership for global environmental policy formation.

Water Equivalent (of Snow) — The depth or amount of water that would result from the complete melting of a sample of deposited snow, measured in inches of water.

Water Exchange — (1) The volume and rate of water exchange between a body of water and the atmosphere. (2) (Oceanography) The volume and rate of water exchange between bodies of water in a given location, controlled by tides, winds, river discharge, and currents.

Water Exports — The artificial transfer (pipes, canals, aqueducts, etc.) of water to one region or subregion from another region. Also see *Interbasin Transfers*, *Water Importation*, and *Water Imports*.

Water Facts [California] — Below are listed some miscellaneous but nonetheless interesting facts about water, some of which are specific to the State of California.

- An acre-foot of water contains about 326,000 gallons.
- An acre-foot of water (43,360 square feet times one foot) would nearly cover the playing surface of a football field (45,000 square feet) to a depth of 1 foot.
- One acre-foot of water is enough to meet the needs of two typical families for a year.
- Landscaping accounts for about one half (50 percent) the water Californians use at home. Showers account for another 18 percent, while toilets use about 20 percent.
- There are two major water projects in the State of California, the *State Water Project (SWP)* and the federal *Central Valley Project (CVP)*. Both of these projects carry water from northern California to central and southern California users.
- These water projects were devised because approximately 75 percent of California's annual precipitation falls north of Sacramento and 25 percent falls south of Sacramento; however, approximately 75 percent of the population of the state lives south of Sacramento and 25 percent lives north of Sacramento.
- About 66,000 acre-feet of water were voluntarily provided by State Water Project and Central Valley Project contractors to assist migrating salmon in year 2001.
- Per capita water use varies around the State of California and is greatly influenced by landscaping and other outdoor

water needs. For example, the state's Central Valley residents use up to 300 gallons per person per day while some Central Coast residents use as little as 50 gallons per day.

- It takes 3.3 acre-feet of water to grow enough food for an average family for a year.
- California will be chronically short of water by the year 2010 unless steps are taken immediately to improve the state's water supply system.
- A major water storage project typically takes 10 to 20 years to design and build.

Water Farm — Real property purchased not for the value of the land or any structures on it, but for its *Appurtenant Water Rights* or access to surface or groundwater. Often agricultural land that is subsequently retired from production. Also referred to as a *Water Ranch*.

Water Flow — The rate of flow of water measured in volume and time (e.g., cubic feet per second, or cfs).

Water Gap — (Geology) (1) A deep, narrow pass across a ridge, mountain, or other area of high elevation through which a river or stream flows. (2) A traverse cleft in a mountain ridge through which a stream flows; the gap cut through a resistant ridge by a superimposed or *Antecedent Stream*.

Water Garden — (1) A garden in which aquatic plants predominate. (2) A garden built about a stream or pool as a central feature.

Water Gate — A gate that provides access to a body of water; a *Floodgate*.

Water Gauge — An instrument indicating the level of water, as in a boiler, tank, reservoir, or stream.

Water Glass — An open tube or box having a glass bottom for making observations below the surface of the water.

Water Hammer — (1) The sound like someone hammering on a pipe that occurs when a valve is opened or closed very rapidly. When a valve position is changed quickly, the water pressure in a pipe will increase and decrease back and forth very quickly. This rise and fall in pressures can do serious damage to the system. (2) Very rapid pressure wave in a conduit due to a sudden change in flow; the potentially damaging slam, bang, or shudder that occurs in a pipe when a sudden change in water velocity (usually as a result of too-rapidly starting a pump or operating a valve) creates a great change in water pressure. (3) A banging noise in steam pipes, caused by steam bubbles entering a cold pipe partially filled with water. (4) A momentary increase in flow or a positive surge in pressure that passes lengthwise along a pipe, usually due to sudden changes in velocity or quantity of fluid in the pipe. Water hammer in a flowing well can occur when a valve is closed rapidly, causing the moving column of water in the well to suddenly slow or stop. The faster the water column is slowed and stopped, the greater the stress or pressure on the casing, joints, and packers and the greater the disturbance of unstable formation materials near the drill hole.

Water Hammer Arresters — Engineered mechanical devices having a cushion of air or gas permanently sealed in the unit, designed to provide continuous protection, without maintenance, against water hammer or excessive water surge pressure.

Water Hole — A small natural depression in which water collects, especially a pool where animals come to drink.

Water Hyacinth — A floating freshwater plant belonging to the genus *Eichhornia*. The plant was introduced into the United States in the late nineteenth century and has become a prolific nuisance weed that clogs waterways in the southern part of the country.

Water Ice — A dessert made of finely crushed ice that has been sweetened and flavored.

Water Importation — The act or process whereby water is brought into an area or region which would not naturally receive such waters. Typically, it refers to the artificial transport of water through aqueducts, canals, or pipelines from one water basin, drainage area, county or *Hydrographic Area* to another, thereby affecting the natural surface and groundwater drainage and flow patterns in both the water exporting and importing areas. In terms of a *Water Banking* or *Water Marketing* concept, such actions to move water from areas of low use to areas of high use place a more realistic monetary value on water as a scarce economic commodity and result in enhanced economic efficiency by putting existing water resources, wherever located, to more productive economic use. However, considerable public concern and controversy surround this practice. These concerns deal primarily with issues relating to altering the natural flows of both surface and groundwaters, adverse environmental and habitat impacts on water exporting areas, the limitations placed on the long-term growth and development of the water exporting region or hydrographic area, the potentially adverse hydrologic effects on groundwater (water table and aquifer) conditions in the exporting area as well as the generally unknown effects on surrounding hydrographic areas and aquifer conditions, and the dependency acquired by the water importing area to continued diversions and water importations. The concept of a public policy limiting an area's development to its natural ability to support population growth only through existing and readily available natural resources, particularly water, is referred to as an *Antediluvian Policy*. Also see *Water Transfer*.

Water Imports — The artificial transfer (pipes, canals, aqueducts, etc.) of water into one region or subregion from another region. Also see *Water Importation*, *Water Exports*, and *Interbasin Transfers*.

Water Impoundment — A body of water created or stored by impoundment structures such as dams, dikes, and levees.

Water Information Network (WIN) [OWOW/EPA] — In partnership with others, the *Office of Wetlands, Oceans, and Watersheds (OWOW)* of the *U.S. Environmental Protection Agency (EPA)* operates the Internet-based Watershed Information Network. WIN is a roadmap to consolidated watershed information and services that can help communities protect and restore water quality. WIN provides ready access to information on such topics as: (a) what a watershed is, (b) how to find a specific watershed, (c) available training for watershed practitioners, and (d) financing watershed protection and restoration activities. Included in WIN is the Index of Watershed Indicators, which compiles information on the health of aquatic resources in over 2,100 watersheds in the 48 contiguous states. Entering a "place" (such as ZIP code, county, tribe, or school) in WIN will generate specific data about a watershed and show the user how they can get involved in watershed issues. OWOW has also modernized EPA's computerized STORage and RETreival system for water quality data, STORET, so that it more effectively meets the emerging information needs for watershed protection. New STORET will serve as EPA's principal repository for chemical data, biological community information, fish tissue analyses, and aquatic habitat evaluations for fresh and marine water. PC-based and user-friendly, new STORET requires quality assurance information to ensure the integrity of the data in the system. Data in new STORET will soon be accessible via the Internet. OWOW is also developing a variety of tools to help states and other

partners geographically display and manage their water information. OWOW's Watershed Information Network provides consolidated watershed information and services that can help communities protect and restore water quality.

Water Infrastructure Network (WIN) — The Water Infrastructure Network is a coalition of public and private water groups, local elected officials, state government organizations, environmental organizations, and others dedicated to developing America's water and wastewater infrastructure. WIN focuses its efforts on resource funding at the federal level. WIN was formed in early 2000 and by April 2000 it had released its first report, "Clean & Safe Water for the 21st Century" (www.amsa-cleanwater.org). The report documented the significant improvements in public health associated with national investments in water and wastewater treatment infrastructure, and projected that drinking and wastewater facilities will need to invest nearly \$1 trillion in treatment plants, distribution systems, and wastewater collection systems over the next 20 years. However, it has been estimated that investment by utilities is falling \$23 billion short of these needs annually due to expensive treatment and technology upgrades needed to comply with new, largely unfunded federal regulatory mandates. If federal funding is not made available to help combat this shortcoming, the report suggests that water and sewer rates across the country will more than double. WIN recognizes that no single solution addresses the full range of water and wastewater infrastructure challenges. For this reason, all levels of government and the private sector must share responsibility for the solutions. In view of this situation, the WIN coalition is seeking new legislation to:

- [1] Create a long-term, sustainable, and reliable source of federal funding for drinking water and wastewater projects;
- [2] Authorize capitalization of the next generation of state financing authorities to distribute funds in fiscally responsible and flexible ways, including grants, loans, loan subsidies, and credit assistance;
- [3] Focus on critical "core" water and wastewater infrastructure needs;
- [4] Streamline federal administration of the funding program and encourage continuous improvement in program administration at both the federal and state level;
- [5] Adequately finance strong state programs to implement the *Clean Water Act (CWA)* and the *Safe Drinking Water Act (SDWA)*;
- [6] Establish a new program for clean and safe water technology and management innovation to reduce infrastructure costs, prolong infrastructure life, and improve the utilities' productivity;
- [7] Provide expanded, targeted technical assistance to communities most in need.

Water Jacket — A casing containing water circulated by a pump, used around a part to be cooled, especially in water-cooled internal-combustion engines.

Water Law — A law that has been instigated to control the right to the use of water. See *(Prior) Appropriation Doctrine* and *Riparian Doctrine*.

Water Law [California] — The keystone to California's water law and policy, as spelled out in the California Constitution, requires that all uses of the State's waters be both reasonable and beneficial. It places a significant limitation on water rights by prohibiting the waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water. California operates under a dual system of water rights for surface water which recognizes both the doctrine of *Riparian Water Rights* and *Appropriative Water Rights*. Under the *Riparian Doctrine*, the owner of land has the right to divert a portion of the natural flow of water flowing by his land for reasonable and beneficial use upon his land adjacent to the stream and within its watershed, subject to certain limitations. Under the *(Prior) Appropriation Doctrine*, a person has a right to divert, store, and use water regardless of whether the land on which it is used is adjacent to a stream or within its watershed, provided that the water is used for reasonable and beneficial uses and is surplus to water from the same stream used by earlier appropriators. The rule of priority between appropriators is "*First in Time, First in Right*". Unlike Nevada which administers both surface and groundwater rights, there exists no statewide system for the administration of groundwater rights in California, except for groundwater that is actually flowing in underground streams or water that flows in known and definite underground channels. Consequently, use of most groundwater in California is unregulated, except in certain circumstances where individual basins have undergone special adjudications or where a local groundwater management district has been established. Water rights in California are administered by the *State Water Resources Control Board (SWRCB)*. Also see *California Doctrine*.

Water Law [Federal] — Except when provided by federal law, e.g., *Federal Reserved (Water) Rights*, federal water rights must satisfy the administration and permitting process of the state in which the federal project is located. An important 1978 U.S. Supreme Court case (*California v. United States*) held that unless state law conflicted with clear Congressional directives, the federal government must obtain water rights under state law for reclamation purposes. Under the federal reserved rights concept, the federal government reserves sufficient water rights when it withdraws land from the public domain to establish a federal reservation such as a national park or Indian reservation. Also see *Reservation Doctrine*, *Reserved Rights Doctrine*, and *Winters Doctrine* and *Winters Rights (Decision)*.

Water Law [Nevada] — Nevada's water law is based on the *Prior Appropriation Doctrine*. Furthermore, unlike some other states, Nevada has a statewide system for the administration of both groundwater and surface water. *Appropriative Water Rights* are based on the concept of applying water to *Beneficial Use* and "*First in Time, First in Right*". Appropriative water rights can be lost through nonuse and they may be sold or transferred apart from the land. Due in large part to the relative scarcity of water in Nevada and numerous competing uses, Nevada has had a thriving market for water transfers for a number of years. Water rights in Nevada are administered by the State Engineer. Also see *Application*, *Water Right*, *Riparian Doctrine*, *Riparian Water Rights*, *Littoral Water Rights*, *Prescribed Water Rights*, and *Reserved Water Rights*.

Water Level — (1) An instrument to show the level by means of the surface of water in a trough or in a U-shaped tube. (2) The surface of still water. (3) The level assumed by the surface of a particular body or column of water. (4) The water-surface elevation or stage of the free surface of a body of water above or below any datum (see *Gage Height*), or the surface of water

standing in a well, usually indicative of the position of the water table or other potentiometric surface. (5) Synonymous with the *Water Table*. (5) The *Water Line* of a ship.

Water-Level Gage — A gage which indicates the water level in a reservoir, stilling well, or other receptacle.

Water Level Pivot Point — A location along the water surface in a canal reach where the water level remains essentially constant during changes in flow.

Water License — A legal document issued to the holder of a water right permit following an on-site investigation of the water use project. A water license documents the extent to which water has been placed to beneficial use.

Water Line — (Nautical) (1) The line on the hull of a ship to which the surface of the water rises. (2) Any of several lines parallel to this line, marked on the hull of a ship, and indicating the depth to which the ship sinks under various loads. (3) A pipeline carrying water. (4) A line marked on a structure or gage to indicate water depth. May be more specifically referred to as a high water line or a low water line when measuring water depths.

Water Loss — (1) The sum of water lost from a given land area during a specified time period by transpiration, evaporation, and interception. (2) In irrigation, seepage and evaporation from land and ditches; excess water drained from the land surfaces and the deep percolation. The basic concept is that water loss is equal to *Evapotranspiration*, that is, water that returns to the atmosphere and thus is no longer available for use. However, the term is also applied to differences between measured inflow and outflow even where part of the difference may be *Seepage*.

Water Losses — Water which is unavailable or lost from a particular containment system.

Water Main — A principal pipe in a system of pipes for conveying water, especially one installed underground.

Water Management — (1) (General) Application of practices to obtain added benefits from precipitation, water, or water flow in any of a number of areas, such as irrigation, drainage, wildlife and recreation, water supply, watershed management, and water storage in soil for crop production. Includes *Irrigation Water Management* and *Watershed Management*. (2) (Irrigation Water Management) The use and management of irrigation water where the quantity of water used for each irrigation is determined by the water-holding capacity of the soil and the need for the crop, and where the water is applied at a rate and in such a manner that the crop can use it efficiently and significant erosion does not occur. (3) (Watershed Management) The analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents. Watershed management for water production is concerned with the quality, quantity, and timing of the water which is produced. Also see *Basin Management*.

Water Marketing — A concept of water transfer and use borne out of increased demand by urban populations for water whereby a holder of water rights is allowed to sell or lease those rights in an open market to the highest bidder. As an example, in the United States one acre-foot of water typically yields only about \$400 on a farm versus \$400,000 in manufacturing (National Geographic Special Edition, *WATER: The Power, Promise, and Turmoil of North America's Fresh Water*, November 1993). Such water marketing arrangements, however, can only succeed where necessary water transport and delivery systems exist between supply points and demand points. There are a variety of transactions that are considered marketing transactions to include intrastate transfers, interstate transfers, interbasin transfers, groundwater, surface water, conserved water, water rights, short-term and long-term arrangements, etc. Also see *Water Banking*.

Water Marketing [California] — The *California Water Plan* includes as its definition of water marketing (1) a permanent sale of a water right by the water right holder; (2) a lease from the water right holder (who retains the water right), allowing the lessee to use the water under specified conditions over a specified period of time; and (3) a sale or lease of a contractual right to water supply under an arrangement whereby the ability of the holder to transfer a contractual water right is usually contingent upon receiving approval from the supplier. An example of this type of arrangement is a sale or lease by a water agency that receives its supply from the *Central Valley Project (CVP)*, the *State Water Project (SWP)*, or another water wholesaler.

Water Mass — (Oceanography) (1) A body of water that can be identified by a particular set of physical and chemical characteristics, often consisting of two or more water types. (2) An oceanographic term that refers to a large body of water whose density characteristics are distinct from the surrounding aquatic environment because of inherent temperature or salinity differences. Water masses are present in all oceans and are formed where water flows from one type of climatic or physiographic region into another. The *North Atlantic Current* is an example of a water mass distinguished by a difference in temperature. It is a relatively warm water body that retains its identity as far north as the Arctic Circle. The huge freshwater volume expelled by the Amazon River into the southern Atlantic Ocean is an example of a water mass distinguished by a difference in salinity. See *Ocean Currents*.

Water Master (also Watermaster) — Often an employee of a court hired to administer a court decree. Also may be an employee of a water department who distributes available water supplies at the request of water rights holders and collects hydrographic data. Also refers to a position within an irrigation project that is responsible for the internal distribution of project water.

Water Meter — An instrument for recording the quantity of water passing through a particular outlet.

Water Mill — A mill whose machinery is moved by water.

Water Molecule — The smallest unit of water (chemical symbol H₂O); consists of two atoms of *Hydrogen* (chemical symbol H) and one atom of *Oxygen* (chemical symbol O).

Water of Crystallization — Water in chemical combination with a crystal, necessary for the maintenance of crystalline properties but capable of being removed by sufficient heat.

Water of Hydration — Water chemically combined with a substance in such a way that it can be removed, as by heating, without substantially changing the chemical composition of the substance.

Water Penetration — The depth to which irrigation water or rain penetrates the soil before the rate of downward movement becomes negligible.

Water Permit — A state license to appropriate water for a beneficial purpose.

Water Pipe — (1) A pipe that is a conduit for water. (2) An apparatus for smoking, such as a *Hookah*, in which the smoke is drawn through a container of water or ice and cooled before inhaling.

Water Plan — A document of issues, policies, strategies, and action plans intended to effectively and economically execute a *Water Planning* process. Also see *Water Policy*.

Water Planning — Water planning is an analytical planning process developed and continually modified to address the physical, economic, and sociological dimensions of water use. As a planning process it must assess and quantify the available supply of water resources and the future demands anticipated to be levied upon those resources. Based upon this continuous supply and demand evaluation, water planning must also give direction for moving water supplies to points of use while encouraging users to be good and effective stewards of available water resources. The water planning process requires constant re-evaluation and updating to address changing social, political, economic, and environmental parameters. While the ultimate objective of such efforts is typically the development of a comprehensive, publicly-supported *Water Plan*, it is also critical to develop and maintain a comprehensive and viable water planning process that covers various aspects of water resource development, transport, water treatment, allocation among various competing uses, conservation, waste-water treatment, re-use, and disposal. Also see *Water Policy*.

Water Policy — Those actions governing the management, administration, and procedures used to implement and direct a formal *Water Planning* process by which water rights, water uses, and water diversions are evaluated, ranked, and allocated on the basis of specific public policy goals and objectives and designated, either by legislative mandate, regulation, or fiat, *Preferred Uses*. Similar in scope and purpose to water planning, a water policy approach to water planning is also inherently concerned with various aspects of water resource development, transport, water treatment, allocation among various competing uses, conservation, waste-water treatment, re-use, and disposal. However, unique to the water policy approach is that water-related actions are specifically governed by pre-determined, publicly-approved water-related stipulations such as environmental impacts, quality of life values, “*Highest and Best Use*” concepts and criteria, water quality standards, conservation issues, industry sector water allocations, economic diversity goals, etc. To effect such a policy approach to water planning, a *Public Scoping* process is essential to ascertain, quantify, and rank the specific policy goals used to allocate limited water resources among competing uses. Also see *Water Plan*.

Water Pollution — (1) (Water Quality) Generally, the presence in water of enough harmful or objectionable material to damage the water’s quality. More specifically, pollution shall be construed to mean contamination of any waters such as will create or is likely to create a nuisance or to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, municipal, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish or other aquatic life, including but not limited to such contamination by alteration of the physical, chemical or biological properties of such waters, or change in temperature, taste, color or order thereof, or the discharge of any liquid, gaseous, radioactive, solid or other substances into such waters. More simply, it refers to quality levels resulting from man’s activities that interfere with or prevent water use or uses. Also see *Water Contaminants*. (2) (Ecology) A general term for the presence in water of substances, usually chemicals or waste matter introduced by human activity, that are harmful to organisms living in the water or to those that drink from it or are otherwise exposed to it.

Water Polo — A goal game similar to soccer that is played in water by teams of swimmers using a ball resembling a soccer ball.

Water Potential — The capability of soil water to do work as compared with free water.

Water Privilege — The right to use water especially as a source of mechanical power.

Water Producing Facility (WPF) — Any device or method, mechanical or otherwise, used for the production of water from the groundwater supplies; a water well.

Water Purification — See *Purification (Water)* and *Purification Process (Water)*.

Water Purveyor — (1) An agency or person that supplies water (usually potable water). (2) Anyone who sells drinking water to the public, usually the owner of a *Public Water Supply System (PWSS)*; a public utility, mutual water company, county water district, or municipality that delivers drinking water to customers.

Water Quality — (1) The chemical, physical, radiological, and microbiological characteristics of water with respect to its suitability for a particular purpose. (2) The chemical, physical, and biological condition of water related to beneficial use. Also see *Drinking Water Standards*, *Drinking Water Standards [Nevada]*, *Water Contaminants*, *Water Treatment Disinfectants*, *Water Treatment Processes*, *Water Treatment Technologies*, *Water Quality Threats*, and *Waterborne Diseases*.

Water Quality-Based Limitations — Effluent limitations applied to dischargers when mere technology-based limitations would cause violations of *Water Quality Standards*. Usually applied to dischargers into small streams.

Water Quality-Based Permit — A permit with an effluent limit more stringent than one based on technology performance. Such limits may be necessary to protect the designated use of receiving waters (e.g., drinking, recreation, industrial, irrigation, etc.).

Water Quality Criteria — A specific level or range of levels of water quality necessary for the protection of a water use; levels of water quality expected to render a body of water suitable for its designated use. The criteria are set for individual pollutants and are based on different water uses, such as a public water supply, an aquatic habitat, and industrial supply, or for recreation.

Water Quality Indicators — Constituents or characteristics of water that can be measured to determine its suitability for use.

Water Quality Limited Segment — A portion of a stream where the condition of the water does not meet water quality standards and/or where standards are not expected to be achieved after *Effluent Limitations* on all *Point Sources (PS)* of water pollution are applied. Therefore, controls beyond the technology-based discharge limits will be required for the stream segment to meet the *Ambient Water Quality Standards*.

Water Quality Management — Planning for the protection of a water’s quality for various *Beneficial Uses*, for the provision of adequate wastewater collection, treatment, and disposal for municipalities and industries, and for activities that might create water quality problems, and regulating and enforcing programs to accomplish the planning goals and laws and regulations dealing with

water pollution control.

“Water Quality Standard” (Defined) [Nevada] — (Nevada Revised Statutes 445A.420) Means the degree of pollution of water or the physical, chemical or biological condition of water, as expressed numerically or descriptively, used for controlling the quality of water in each segment of a stream and each other body of surface water in the State of Nevada.

Water Quality Standards — (1) A plan for water quality management containing four major elements: water use; criteria to protect uses; implementation plans, and enforcement plans. An anti-degradation statement is sometimes prepared to protect existing high quality water sources. (2) State-adopted and *U.S. Environmental Protection Agency (EPA)* approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Water Quality Standards [EPA] — Provisions of state or federal law which consist of a designated use or uses for the waters of the United States, water quality criteria for such waters based upon such uses. Water quality standards are to protect public health or welfare, enhance the quality of the water and serve the purposes of the *Clean Water Act* (40 CFR 131.3) (*U.S. Environmental Protection Agency* 1983) a law or regulation that consists of the beneficial designated use or uses of a waterbody, the numerical and narrative water-quality criteria that are necessary to protect the use or uses of that particular waterbody, and an *Antidegradation Statement*.

Water Quality Threats — The following table lists typical water quality threats (contaminants) by source and site.

Source of Contamination	Contaminant	Typical Sites
Natural	Dissolved minerals	Mineral deposits, mineralized waters, hot springs, sea water intrusion
	Asbestos	Mine tailings, serpentine formations
	Hydrogen-sulfide	Subsurface organic deposits
	Radon	Most geologic formations
Commercial Businesses	Gasoline	Service stations' underground storage tanks
	Solvents	Dry cleaners, machine shops
	Toxic metals	Photo processors, laboratories, metal plating works
Municipal	Microbial agents, nutrients, and miscellaneous liquid wastes	Bacteria and virus contaminants from a variety of sources such as sewage discharges and storm water runoff, contributions from industrial dischargers, households, and septic tanks
Industrial	VOCs, industrial solvents, toxic metals, acids	Electronics manufacturing, metal fabricating and plating, transporters, storage facilities, hazardous waste disposal
	Pesticides and herbicides	Chemical formulating plants
	Wood preservatives	Pressure treating power poles, wood pilings, railroad ties
Solid Waste Disposal	Solvents, pesticides, toxic metals, organics, petroleum wastes, and microbial agents	Disposal sites which receive waste from a variety of industries, municipal solid wastes, wasted petroleum products, household waste
Agricultural	Pesticides (herbicides, fumigants, fungicides), fertilizers, concentrated mineral salts, microbial agents	Irrigated farm runoff, agriculture chemical applications, fertilizer usage, chemical storage at farms and applicators' air strips, agricultural produce packing sheds and processing plants, meat processing plants, dairies and feed lots
Disasters	Solvents, petroleum products, microbial agents, other hazardous materials	Earthquake, storm, or accident caused pipeline and storage tank failures and damage to sewage treatment and containment facilities; major spills of hazardous materials; flood water contamination of storage reservoirs and groundwater sources

Water Ranching (Ranch) — The purchase of agricultural lands solely for the purpose of acquiring associated water rights or underlying groundwater. Also see *Water Farm*.

Water Reactive — Describing any substance that reacts spontaneously with water to release a flammable or toxic gas, such as sodium metal.

Water Reclamation — (1) The treatment of water of impaired quality, including brackish water and sea water, to produce a water of suitable quality for the intended use. (2) (Wastewater Treatment) A process by which water used in houses and businesses goes down the drain and becomes wastewater, which is then cleaned using biological and chemical processes so the water can be returned to the environment.

Water Recycling — The treatment of urban waste water to a level rendering it suitable for a specific, direct, beneficial use.

Water Regimen — See *Regimen*.

Water-Related Disaster — A cyclic event involving water during which there is threat to or loss of human life or property (e.g., flood, hurricane, tsunami, etc.).

Water-Related Disease — An epidemic event caused by *Waterborne* virus or bacteria. Also see *Waterborne Disease Outbreak*.

Water-Related Issue — An allocation, use, rights, or environmental problem involving water that is complicated by the disagreement of two or more parties over the cause, effect, and/or resolution of the problem.

Water-Related Land — Land on which projected use and/or management practices may significantly affect the runoff pattern or quality of the water resources to which it relates and land that is significantly affected by existing or proposed measures for management or use of the water resources to which it relates.

Water-Related Recreation Activity — A recreation activity dependent upon or enhanced by water, including swimming, boating, water skiing, fishing, picnicking, camping, sightseeing, hiking, and nature walks.

Water-Repellent — Resistant to penetration by water but not entirely *Waterproof*. Synonymous with *Water-Resistant*.

Water Requirement — The total quantity of water, regardless of its source, required for a specified use under a predetermined or prescribed situation.

Water Requirement (Agriculture) — The total quantity of water, regardless of its source, required for production of crops at their normal growth under field conditions. It includes applied water, subsurface irrigation, and precipitation needed by the crops.

Water Reservation — A water right granted by a state entity (commonly to public entities and on behalf of the public) for existing or future beneficial uses or for the maintenance of a minimum instream flow, water level, or quality of water.

Water-Resistant — Synonymous with *Water-Repellent*.

Water Resource(s) — The supply of groundwater and surface water in a given area.

Water Resource District — A legal entity established by state statute to facilitate local administration in all phases of water development, utilization, and control.

Water Resource Management — The decision-making, manipulative, and non-manipulative processes by which water is protected, allocated, or developed.

Water Resource Plan — A planning document or process which assesses both sources and uses of water and develops strategies for their most effective and efficient use according to public needs and criteria. Also see *Water Plan*, *Water Planning*, and *Water Policy*.

Water Resource Region — Natural drainage basin or hydrologic area that contains either the drainage area of a major river or the combined areas of a series of rivers.

Water Resources Research Act [USDI] — The Water Resources Research Act (42 USC 109 et seq.), originally passed in 1964 and subsequently re-authorized in 1996 as Public Law 101-147, provides for establishing and partially funding a *Water Resources Research Institute (WRR)* in each of the 50 states, the trust territories, and the District of Columbia, for a total of 54 WRRIs nationwide. The Water Resources Research Institute for each state is located at the state land-grant university or a college or university designated by the Governor or State Legislature. Combined, these *National Institutes for Water Resources (NIWR)*, as they are also called, under the authority and direction of the Secretary of the U.S. Department of the Interior (USDI), combine the capabilities and talents of 54 water research institutes which possess extensive involvement and experience in water-related problems and issues in their respective states and regions. In addition, many of these institutes also maintain a national and international presence in water research. In this capacity, the NIWRs have established themselves as a primary link among and between water-related personnel in the academic community, local, state, and federal governments, and the private sector. Specifically, the NIWRs have established research collaboration with 123 other universities, 148 state agencies, and over 273 private sector, local government or other entities. In addition, 179 federal agency contacts have cooperated at different levels with various WRRIs. The programmatic responsibilities stipulated by the Water Resources Research Act provide a unified focus for the federal and non-federal components within the *National Water Resources Research Institute Program*. Each state-based program promotes research, training, information dissemination, and other activities meeting the needs of the states and the nation and encourages regional cooperation among institutes for further research into areas of water management, development, and conservation that have a regional or national character. Under the Act, the WRRIs are to:

- [1] Plan, conduct and otherwise arrange for competent research that fosters (a) the entry of new research scientists into the water resources fields, (b) the training and education of future water scientists, engineers and technicians, (c) the preliminary exploration of new ideas that address water problems or expand understanding of water and water-related phenomena, and (d) the dissemination of research results to water managers and the public; and
- [2] Cooperate closely with other colleges and universities in the state that have demonstrated capabilities for research, information dissemination, and graduate training in order to develop a statewide program designed to resolve state

and regional water and related land problems. Each institute shall also cooperate closely with other institutes and organizations in the region to increase the effectiveness of the institutes and for the purpose of promoting regional coordination.

The success of the Water Resources Research Act and the resultant National Water Resources Research Institute Program is intended to ensure a continuing flow of water scientists and managers to the profession. The program includes on-campus professional and academic training and off-campus continuing education. Students receive professional training by participating in institute-sponsored research and information transfer projects. Seminars and specialized course work for graduate and undergraduate students also are sponsored.

Water Resources Research Institute (WRRI) — Research institutes typically found in each state which conducts basic and applied research to solve water problems unique to their area. The bulk of Institute funding comes from non-federal sources. The Water Resources Research Institute for each state is located at a college or university designated by the Governor or State Legislature. Also referred to as *National Institutes for Water Resources (NIWR)* [USDI]. Also see *Water Resources Research Act* and *National Water Resources Research Institute Program* [USDI].

Water Resources Subregion — A subregion or subregions of a *Water Resource Region* that includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage area.

Water Resources Regions [United States] — A designated natural *Drainage Basin* or *Hydrologic Area* that contains either the drainage area of a major river or the combined drainage areas of two or more rivers. Of the 21 designated water-resources regions, delineated by the *Water Resources Council* in 1970, 18 are in the conterminous United States, and one each are in Alaska, Hawaii, and Puerto Rico. The following represents a listing of U.S. water-resources regions and the states primarily and partly included:

- [1] **Region 01 – New England Region** (Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, and part of Vermont)
- [2] **Region 02 – Mid-Atlantic Region** (New York, Pennsylvania, New Jersey, Maryland, Washington D.C., Virginia, and parts of Vermont and West Virginia)
- [3] **Region 03 – South Atlantic–Gulf Region** (North Carolina, South Carolina, Georgia, Alabama, Florida, and parts of Virginia and Mississippi)
- [4] **Region 04 – Great Lakes Region** (Michigan, and parts of Wisconsin, Indiana, Ohio, and New York)
- [5] **Region 05 – Ohio Region** (Indiana, Ohio, West Virginia, Kentucky, and parts of Illinois, Tennessee, Virginia, Pennsylvania, and New York)
- [6] **Region 06 – Tennessee Region** (Tennessee and parts of Alabama, Georgia, Virginia, and North Carolina)
- [7] **Region 07 – Upper Mississippi Region** (Minnesota, Wisconsin, Iowa, Illinois, and parts of Missouri and Indiana)
- [8] **Region 08 – Lower Mississippi Region** (parts of Arkansas, Mississippi, Louisiana, Tennessee, Kentucky, and Missouri)
- [9] **Region 09 – Souris–Red–Rainy Region** (parts of North Dakota and Minnesota)
- [10] **Region 10 – Missouri Region** (Montana, Wyoming, North Dakota, South Dakota, Nebraska, and parts of Colorado, Kansas, Missouri, Iowa, and Minnesota)
- [11] **Region 11 – Arkansas–White–Red Region** (Oklahoma and parts of Colorado, New Mexico, Kansas, Texas, Missouri, Arkansas, and Louisiana)
- [12] **Region 12 – Texas–Gulf Region** (Texas and parts of New Mexico and Louisiana)
- [13] **Region 13 – Rio Grand Region** (New Mexico and parts of Texas and Colorado)
- [14] **Region 14 – Upper Colorado Region** (parts of Utah, Colorado, Wyoming, Arizona, and New Mexico)
- [15] **Region 15 – Lower Colorado Region** (Arizona and parts of California, Nevada, Utah, and New Mexico)
- [16] **Region 16 – Great Basin Region** (Nevada and parts of Utah, California, Oregon, Idaho, and Wyoming)
- [17] **Region 17 – Pacific Northwest Region** (Washington, Oregon, Idaho, and parts of Montana, Wyoming, Nevada, and Utah)
- [18] **Region 18 – California Region** (California and parts of Oregon and Nevada)
- [19] **Region 19 – Alaska Region** (Alaska)
- [20] **Region 20 – Hawaii Region** (Hawaii)
- [21] **Region 21 – Caribbean Region** (Puerto Rico)

Also see *Hydrologic Unit Maps* [USGS] and *Hydrologic Units (Classification Codes)* [USGS].

Water Resources Sub-Region [United States] — The 21 *Water Resources Regions* of the United States as designated by the *Water Resources Council* are further subdivided into 222 sub-regions. Each sub-region includes that area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage system. Also see *Hydrologic Unit Maps* (USGS) and *Hydrologic Units* (USGS).

Water Resources Sub-Area — An approximation of a *Water Resources Sub-Region* using county boundaries. Also see *Water Resources Region* [United States].

Water Right — (1) A water appropriation for which a water license has been issued. (2) The legal right to use a specific quantity of water, on a specific time schedule, at a specific place, and for a specific purpose. (3) A legally-protected right, granted by law, to take possession of water occurring in a water supply and to put it to *Beneficial Use*. (3) A legal right to divert state waters for a beneficial purpose.

Water Right Application — See *Application, Water Right*.

Water Right Permit — A legal document issued to the holder of an approved application to appropriate water. A water right permit includes a description of the approved water appropriation, time frame to complete construction of works and application of water to beneficial use, and other qualifications regarding use of the water.

Water-Righted Acreage — The land base for which there are water rights.

Water Rights — (1) The legal rights to the use of water. (2) A grant, permit, decree, appropriation, or claim to the use of water for beneficial purposes, and subject to other rights of earlier date or use, called *Priority* or *Prior Appropriation*. They consist of *Riparian Water Rights*, *Appropriative Water Rights*, *Prescribed Water Rights*, and *Reserved Water Rights*. Also see *Water Law*, *Water Law [California]*, *Water Law [Federal]*, and *Water Law [Nevada]*.

Water Rights, Correlative Doctrine — When a source of water does not provide enough for all users, the water is reapportioned proportionately on the basis of prior water rights held by each user.

Water Sample — A representative part of a portion used to determine quality of a larger body of water.

Water Service Agency — An agency organized, founded, or established to produce and distribute water directly or indirectly to customers. The two major types are privately owned companies which consist of commercial companies and mutual water groups; and public companies which include water districts and municipally-owned water departments.

Water Service Reliability — The degree to which a water service system can successfully manage water shortages.

Water Shortage — The lessened water supply conditions existing in an aquifer during a period of substantially less than average annual recharge.

Water-Sick — Land rendered unproductive because of excessive irrigation.

Water Snow — Snow that yields a high content of water when melted.

Water Softener — An apparatus designed to remove divalent metal ions (the most important of these being calcium, magnesium, and iron) from water, often replacing the divalent or trivalent ions with the monovalent sodium ion. See *Ion Exchange*.

Water Softening — Any process, but most usually involving ion exchange, for removing from water, in whole or in part, those *Cations* which produce hardness (primarily calcium and magnesium). Also see *Hard Water* and *Hardness*.

Water Solubility — The maximum possible concentration of a chemical compound dissolved in water. If a substance is *Water Soluble* it can very readily disperse through the environment.

Water Soluble — Of a material that dissolves in water.

Water Spreading — (1) (General) Diverting runoff from natural channels or gullies by means of a system of dams, dikes, or ditches, and spreading it over relatively flat areas. The purpose is to increase the growth of natural vegetation or to infiltrate and recharge the groundwater for subsequent withdrawal by pumps for irrigation. Also see *Artificial Recharge*. (2) (Reclamation Projects) A controversial practice of using surface water from *U.S. Bureau of Reclamation (USBR)* irrigation projects to grow crops outside district boundaries. As of 1995, it was estimated that across the 17 Western states water spreading occurred on at least 1.8 million irrigated acres.

Water Spreading Methods — Refers to surface irrigation by border or furrow.

Water Storage Pond — An impound for liquid wastes designed to accomplish some degree of biochemical treatment. Also see *Waste Treatment Lagoon*.

Water Supplier — One who owns or operates a *Public Water System (PWS)*.

Water Supply — (1) Any quantity of available water; a *Water System*. (2) The water available for a community or region. (3) The source and delivery system of such water.

Water Supply System — The collection, treatment, storage, and distribution of potable water from source to consumer. Includes the works and auxiliaries for collection, treatment, storage, and distribution of the water from the sources of supply to the free-flowing outlet of the ultimate consumer. Also see *Public Water System (PWS)*.

Water Surface Elevation — (1) Generally, the elevation of a water surface above or below an established reference level, such as (mean) sea level. (2) The height, in relation to the *National Geodetic Vertical Datum (NGVD)* of 1929, or other datum, of a body of water or, for flood determination, for the specification of floods of various magnitudes and frequencies in the floodplains or coastal or riverine areas. Also see *Mean Sea Level (MSL)*.

Water System — (1) A river and all its tributaries. (2) A *Water Supply*, e.g., a *Public Water System (PWS)*. Also see *River System*.

Water Table — (1) The surface of a groundwater body at which the water is at atmospheric pressure; the upper surface of the groundwater reservoir. (2) The surface between the *Vadose Zone* and the groundwater; that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere. (3) The upper surface of the *Saturated Zone* that determines the water level in a well in an *Unconfined Aquifer*. Also referred to as the *Groundwater Table* or *Phreatic Surface*. (4) The level of groundwater; the upper surface of the *Zone of Saturation* for underground water. It is an irregular surface with a slope or shape determined by the quantity of groundwater and the permeability of the earth material. In general, it is highest beneath hills and

mountains and lowest beneath valleys. Also referred to as *Groundwater Table*.

Water-Table Aquifer — An *Unconfined Aquifer* within which is found the water table.

Water Table, Perched — The surface of a local zone of saturation held above the main body of groundwater by an impermeable layer or stratum, usually clay, and separated from the main body of groundwater by an unsaturated zone.

Water Tower — A standpipe or elevated tank used as a reservoir or for maintaining equal pressure in a water system.

Water Transfer(s) — (1) Artificial conveyance of water from one area to another across a political or hydrological boundary. This is referred to as an import or export of water from one basin (inter-basin) or county (inter-county) to another. (2) Marketing arrangements that can include the permanent sale of a water right by the water right holder; a lease of the right to use water from the water right holder; the sale or lease of a contractual right to water supply. Also see *Water Importation*.

Water Trap — (Geology) A section of a cave in which the roof drops below the water level, thus filling the area with water.

Water Treatment — Processes undertaken to purifier water acceptable to some specific use, e.g., drinking. Most water treatment processes include some form, or combination of forms, of sedimentation, filtration, and chlorination.

Water Treatment, Combined Technique — A relatively new water disinfection technique greatly reducing the need for chlorination while effectively destroying up to 99.9 percent of *coliphage* (intestinal bacteria) in raw water. The method combines two purification techniques that have been previously used separately for water purification – potassium permanganate and copper/silver ions – but in combination the processes kill bacteria up to 10 times faster than metal ions alone and up to 5 times faster than potassium permanganate alone.

Water Treatment Disinfectants — The following table lists primary water disinfectants, advantages, disadvantages, and point of application.

Disinfectant	Advantages	Disadvantages	Point of Application
Chlorine	Very effective; has a proven history of protection against waterborne disease. Widely used. Variety of possible application points. Inexpensive. Appropriate as both primary and secondary disinfectant. Operators can easily test for chlorine residual throughout the water system.	Potential for harmful by-products under certain conditions	Towards the end of the water treatment process so that water is as clarified (organic free) as possible, thereby minimizing THM (trihalomethane) formation and providing secondary disinfection.
Ozone	Very effective. Minimal harmful by-products identified to date.	Relatively high cost. More complex operations because it must be generated on site. Requires a secondary disinfectant.	Prior to the rapid mixing in all treatment processes. In addition, sufficient time for biodegradation of the oxidation products of the ozonation of organic compounds is recommended prior to secondary treatment.
Ultraviolet radiation	Very effective for viruses and bacteria. Readily available. No known harmful residuals. Simple operation and maintenance for high quality waters.	Inappropriate for surface water. Requires a secondary disinfectant.	Towards the end of the water treatment process to minimize the presence of other contaminants that interfere with this disinfectant and to minimize operating problems.

Water Treatment Lagoon — An impound for liquid wastes designed to accomplish some degree of biochemical treatment. Also referred to as *Waste Treatment Lagoon* and *Water Storage Pond*.

Water Treatment Plants — Facilities that treat water to remove contaminants so that it can be safely used.

Water Treatment Processes — Natural water treatment processes encompass the *Hydrologic Cycle* whereby the earth's waters are continually recycled and cleansed through a myriad of natural processes including evaporation (distillation), settlement in natural holding water bodies, filtration through rocks and soils (percolation), the decomposition of organic materials by naturally-occurring microorganisms, and the destruction of water-borne pathogenic bacteria, parasites, and viruses by the sun's ultraviolet rays. Due to man's intervention, however, and the large quantities of wastewater produced by urban areas, the earth's natural recycling process becomes overwhelmed and unable to accommodate the increased loads of pollutants. Therefore, treatment processes become essential to returning the earth's waters to usable states for further processing and consumption. The following presents these treatment process and the use to which each processes water may be applied:

- [1] **Primary Treatment** – This process removes a large portion of solids contained in wastewater by means of

sedimentation. Flocculated water, or water that has been treated with chemicals to encourage large particles to stick together to form flocs, is placed in holding tanks which allow these materials to settle out. Waters derived from this process can be applied by surface irrigation on fiber, fodder, and seed crops not consumed by humans.

- [2] **Secondary Treatment** – This process takes waters from primary treatment and subjects them to biological treatment processes involving oxidation and sedimentation, along with the possibility of disinfection. Waters derived from this process can be applied by surface irrigation on orchards, vineyards, trees and vines and, under more restrictive conditions, to golf courses, certain greenbelts not used by the public, and other landscaping.
- [3] **Tertiary Treatment** – This process takes waters from secondary treatment sources and further subjects them to coagulation, flocculation, clarification, filtration, and disinfection. Waters derived from tertiary treatment can be applied by spray irrigation on parks, playgrounds, recreation lakes, golf courses, schoolyards, industrial uses, the environment, and numerous edible food crops.
- [4] **Advanced Treatment** – The final treatment process includes treating tertiary treated water by methods which might include organics removal by granulated carbon and membranes filters to remove micro-constituents. Some membrane technologies also provide a barrier to salts and ionic contaminants and are also considered more effective than conventional sand filters at filtering out microorganisms to include specific pathogens. Part of this process to produce potable (drinkable) water may involve allowing the final product water to be stored in underground aquifers or surface reservoirs for lengthy periods and then be blended with other waters before final processing into the final use of drinking water.

The following table presents preliminary and main water treatment processes and their purpose:

Process/Step	Treatment Purpose
Preliminary Treatment Processes	
Screening	Removes large debris (leaves, sticks, fish) that can foul or damage plant equipment
Chemical pretreatment	Conditions the water for removal of algae and other aquatic nuisances
Presedimentation	Removes gravel, sand, silt, and other gritty material
Microstraining	Removes algae, aquatic plants, and small debris
Main Treatment Processes	
Chemical feed and rapid mix	Adds chemicals (coagulants, Ph adjusters, etc.) to water
Coagulation/flocculation	Converts nonsettleable to settleable particles
Sedimentation	Removes settleable particles
Softening	Removes hardness-causing chemicals from water
Filtration	Removes particles of solid matter which can include biological contamination and turbidity
Disinfection	Kills disease-causing microorganisms
Adsorption using granular activated carbon (GAC)	Removes radon and many organic chemicals such as pesticides, solvents, and trihalomethanes (THM)
Aeration	Removes volatile organic chemicals (VOCs), radon, H ₂ S, and other dissolved gases; oxidizes iron and manganese
Corrosion control	Prevents scaling and corrosion
Reverse osmosis, electrodialysis	Removes nearly all inorganic contaminants
Ion exchange	Removes some inorganic contaminants, including hardness-causing chemicals
Activated alumina	Removes some inorganic contaminants
Oxidation filtration	Removes some inorganic contaminants (e.g., iron, manganese, radium)

Water Treatment Technologies — As raw water supplies become less pristine in terms of water quality, greater reliance must be placed on the application of technology to restore these water sources to quality standards. Increasingly, water recycling and desalting have become more important to restoring water supplies, particularly for urban uses. Water treatment technologies incorporate those methods and techniques used to transform these lower quality raw water sources into reliable, high-quality water supplies. The following is a listing of some of the more important water treatment technologies:

- [1] **Activated Carbon Adsorption** – Brings contaminated water in direct contact with activated carbon in granular or powdered form, causing the contaminants to be adsorbed onto the carbon. The process may be accomplished by

tach, column, or fluidized-bed operations with the spent carbon either regenerated or disposed of. In addition to the traditional use of activated carbon for taste and odor control and dechlorination, carbon adsorption is widely used for the removal of volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). Granular activated carbon (GAC) adsorption is a unit process with a proven ability to remove a broad spectrum of organic chemicals from water. Powdered activated carbon (PAC) has traditionally been used to control taste and odor in water, and is also used for the removal of certain SOCs, especially pesticides.

- [2] **Air-Stripping** – A treatment process used to remove VOCs from contaminated water. Countercurrent air-stripping in a packed tower aeration (PTA) system is the most common process with the unit's conventional configuration consisting of a tower with water inflow at the top and air inflow at the bottom. The tower is filled with small diameter random packing. As clean air moves upward, the VOCs transfer from the water phase into the air phase. Treated water exits from the bottom and the air containing VOCs exits from the top either directly into the atmosphere or into a gas treatment system in accordance with allowable VOC emission standards. The closed-loop air-stripping process represents an innovative extension of this process which combines traditional air-stripping with an ultraviolet photo-oxidation process to control VOC emissions. As a result of UV radiation and a photo-oxidation chamber, the VOCs are destroyed and the end products consist of carbon dioxide, hydrochloric acid, and ozone. The treated air is then recycled to the PTA unit.
- [3] **Advanced Oxidation** – In contrast to adsorption techniques, advanced oxidation processes (AOPs) can destroy organic contaminants rather than transferring them from one medium to another. Examples of this process include treatment with ultraviolet (UV) radiation, ozone/hydrogen peroxide, and ozone/UV. AOPs provide more powerful oxidation and at faster rates than conventional oxidants such as chlorine. As a result, they can remove compounds which are not treatable with conventional oxidants, as well as reduce disinfection by-products created by processes such as chlorination. Presently, much of the work done with AOPs has focused on removing low-molecular weight solvents such as trichloroethane (TCE) and perchloroethylene (PCE) from contaminated groundwater, as well as on the reduction of disinfection by-products (DBPs) from the chlorination process.
- [4] **Membrane Technologies** – These technologies include reverse osmosis (RO), electrodialysis, microfiltration (MF), ultrafiltration (UF), and nanofiltration (NF). RO, MF, UF, and NF are pressure-driven processes of barrier separation; electrodialysis employs electrical potential as the driving force. Membrane processes have been used for desalination, removal of dissolved organic materials, water softening, liquid-solid separation, pathogen removal, and heavy metals removal. Other membrane processes include membrane phase-contact processes which are not pressure driven but remove contaminants by extraction into another phase, similar to air-stripping and solvent extraction methods.
- [5] **Ion-Exchange** – In this process, contaminated water is passed through a packed bed of anion or cation resins, which are selected based on the particular contaminant to be removed. The treatment process exchanges ions between the resin bed and contaminated water. By displacing ions in the resin, contaminant ions become part of the resin and are removed from the process water. In the ion-exchange process, the resin becomes depleted and periodically needs to be regenerated to maintain effectiveness. This is done by using a sodium chloride brine solution. The process is widely used for removing nitrates in groundwater and for removing some metals, as well as water softening.
- [6] **Chemical Precipitation** – This process is used for removing heavy metals from water in which the contaminants are precipitated from solution and removed by settling. There are several types of chemical addition systems including ones using carbonates, hydroxides, and sulfides. The carbonate system uses soda ash and pH adjustment. The hydroxide system is most widely used for removing inorganics and metals and uses lime or sodium hydroxide to adjust the pH upward. The sulfide system removes most inorganics (except arsenic), but has the disadvantage that sulfide sludges are susceptible to oxidation to sulfate when exposed to air, resulting in resolubilization of the contaminants.
- [7] **Biological Treatment** – A process which uses microorganisms to remove contaminants in water through metabolic processes. The process can be a suspended growth system, where the microorganisms and nutrients are introduced in an aeration basin as suspended material in a water-based solution, or a fixed-film system where the microorganisms attach to a medium which provides inert support. This process is used in municipal wastewater treatment plants and for treating water containing organic compounds such as petroleum hydrocarbons. Biological treatment is often used for the remediation of leaking fuel tank sites, either *in situ* or above ground.
- [8] **Disinfection** – This treatment process inactivates pathogens in water. The most common and widely used such disinfection process is chlorination, often used to treat wastewater and drinking water. Other, more recent treatment processes applied in water recycling include ultraviolet (UV) radiation and ozonation. UV has been shown to be as effective as chlorine or ozone in reducing coliform bacteria and is more effective at virus removal, as well as eliminating the disinfection by-products (DBPs) and handling hazards associated with the use of chlorine.
- [9] **Innovative Treatment Technologies** – Include a number of processes being used and tested to treat contaminated groundwater at hazardous waste sites. These technologies typically combine basic processes with a few special

techniques. An example is the EnviroMetal Process, a proprietary technology which treats groundwater in situ using reactive metal (usually iron) to enhance the abiotic degradation of dissolved halogenated organic compounds. In this process, a permeable treatment wall of the coarse-grained reactive metallic media is installed across a plume of contaminated groundwater, breaking down contaminants as they migrate through the aquifer. Other processes included integrated vapor extraction and steam vacuum stripping to remove VOCs; steam-enhanced extraction to enhance vapor and liquid extraction thermally; subsurface volatilization and ventilation techniques to treat subsurface organic contamination; the proprietary PACT wastewater treatment system that combines biological treatment and PAC adsorption to contaminated water; and capacitive deionization desalting techniques which are also used for desalination as well as to remove trace metals and suspended colloids by electrodeposition and electrophoresis.

The following table presents water treatment technologies, options, and acceptability.

Treatment Requirements	Technology Options to Meet Regulatory Requirements	Stage of Acceptability	Comments
Filtration of surface water supplies to control turbidity and microbial contamination	Slow sand filtration	Established	Operationally simple; low operating cost; requires relatively low turbidity source water
	Package plant filtration	Established	Compact; variety of process combinations available
	Ultrafiltration (membrane filtration)	Emerging	Experimental, expensive
	Cartridge filtration	Emerging	Experimental, expensive
Disinfection	Chlorine	Established	Most widely used method; concerns about health effects of by-products
	Ozone	Established	Very effective but requires a secondary disinfectant, usually some form of chlorine
	Ultraviolet radiation	Established	Simple, no established harmful by-products, but requires secondary disinfectant, usually some form of chlorine
Organic contamination control	Granular activated carbon (GAC)	Best Available Technology (BAT)	Highly effective; potential waste disposal issues; expensive
	Packed column aeration	Best Available Technology (BAT)	Highly effective for volatile compounds; potential air emissions issues
	Diffused aeration	Established	Variable removal effectiveness
	Multiple tray aeration	Established	Variable removal effectiveness
	Higee aeration	Experimental	Compact, high energy requirements; potential air emissions issues
	Mechanical aeration	Experimental	Mostly for wastewater treatment; high energy requirements, easy to operate
	Catenary grid	Experimental	Performance data scarce; potential air emissions issues
Inorganic contamination control	Membranes (reverse osmosis and electrodialysis)	Established	Highly effective; expensive; potential waste disposal issues
	Ion exchange	Established	Highly effective; expensive; potential waste disposal issues

Treatment Requirements	Technology Options to Meet Regulatory Requirements	Stage of Acceptability	Comments
	Activated alumina	Established	Highly effective; expensive; potential waste disposal issues
	Coagulation/Filtration	Established	May be difficult for very small systems
	Aeration	Established	Preferred technology for radon removal
	Granular Activated Carbon (GAC)	Established	Highly effective for radon removal; potential waste disposal issues
Corrosion controls	pH control	Established	Potential to conflict with other treatments
	Corrosion inhibitors	Established and emerging	Variable effectiveness depending on type of inhibitor

Water Type — (Oceanography) Seawater of a particular temperature and salinity.

Water Use — The amount of water needed or used for a variety of purposes including drinking, irrigation, processing of goods, power generation, and other uses. The amount of water used may not equal the amount of water withdrawn due to water transfers or the recirculation or recycling of the same water. For example, a power plant may use the same water a multiple of times but withdraw a significantly different amount. Also see *Water Use, Types*, below.

Water Use Efficiency — (1) A measure of the crop production per unit of water used, irrespective of water source, expressed in units of weight per unit of water depth per unit area. (2) Marketable crop production per unit of water consumed in evapotranspiration. The concept of utilization applies to both *Dryland Farming* and irrigated agriculture.

Water Use, Industrial — The following table presents water usage rates for the manufacturing industry by major industrial group based on Standard Industrial Classification (SIC) Code. These results were obtained from a 1994 California survey and present total water use by industry sector in *Gallons per Employee per Working Day (GEWD)*.

SIC Code	Major Industrial Group	Water Use (GEWD)
20	Food and kindred products	2,096
21	Tobacco products	1,486
22	Textile mill products	1,174
23	Apparel and other products made from fabrics and similar materials	26
24	Lumber and wood products, except furniture	1,714
25	Furniture and fixtures	179
26	Paper and allied products	2,039
27	Printing, publishing, and allied industries	313
28	Chemical and allied products	1,017
29	Petroleum refining and related industries	11,945
30	Rubber and miscellaneous plastic products	119
31	Leather and leather products	260
32	Stone, clay, glass, and concrete products	2,157
33	Primary metal industries	507
34	Fabricated metal products, except machinery and transportation equipment	197
35	Industrial and commercial machinery and computer equipment	124
36	Electronic and other electrical equipment and components, except computer equipment	265
37	Transportation equipment	173
38	Measuring, analyzing, and controlling equipment; photographic, medical, and optical goods; watches and clocks	127
39	Miscellaneous manufacturing industries.	63

Water Use Practices — Direct, indirect, consumptive, and nonconsumptive uses of water. These include domestic practices (e.g., washing, bathing, cooking, drinking), navigation, wildlife habitat management, irrigation practices, recreation activities, industrial uses, and hydroelectric power generation.

Water Use, Types — The use of water may be classified by specific types according to distinctive uses, such as the following:

- [1] Commercial Water Use
- [2] Domestic Water Use
- [3] Hydroelectric Power Water Use
- [4] Irrigation Water Use
- [5] Livestock Water Use
- [6] Mining Water Use
- [7] Navigational Water Use
- [8] Other Water Use
- [9] Public Water Use (same as *Utility Water Use*)
- [10] Residential Water Use (same as *Domestic Water Use*)
- [11] Rural Water Use
- [12] Thermoelectric Power Water Use

Water Vapor — Water in a gaseous state, especially when diffused as a vapor in the atmosphere and at a temperature below boiling point.

Water Wave — Water waves provide one of the most important mechanisms for transporting energy from one point to another on the sea surface. They are produced when the air-sea interface is distorted by a disturbing force such as the wind. A restoring force such as gravity, surface tension, or the *Coriolis Effect* (force) then acts to return the surface to its equilibrium position. The disturbance propagates on the surface of the water as a wave. Surface water waves may be classified according to the period (frequency) of the wave, and the nature of the disturbing and restoring forces at different periods determines the characteristics of the wave. See *Wave Period*.

Water Well — An excavation where the intended use is for location, acquisition, development, or artificial recharge of groundwater.

Water Well Report (Permitting) — A report which a water well contractor or landowner who is constructing his own well submits to a water resources department. It includes the location and dimensions of the well, its flow, a record of geologic materials encountered in drilling, the temperature of the groundwater, possible chemical analysis of the water, constituent levels, and other relevant data.

Water Wheel — (1) A device such as a turbine or similar engine to transform the energy of flowing water into mechanical power. (2) A wheel with buckets attached to its rim for raising water.

Water Wings — A device consisting of a pair of joined inflatable waterproof bags that fit under the arms of a person, especially a child learning to swim, and provides buoyancy.

Water Witch — A person who predicts the presence of underground water with hand-held tools such as forked twigs (*Divining Rod*) or metal rods. The *United States Geological Survey (USGS)* and the National Water Well Association do not advise against using a water witch to search for groundwater, but say that there is no scientific basis for the belief in water witchery. Also see *Douse* (also *Dowse* or *Dowsing*).

Water Withdrawal — Water removed from groundwater or surface water for use.

Water Works — All of the pipes, pumps, reservoirs, dams and buildings that make up a water system.

Water Year — (1) The 12-month period, October 1 through September 30. The water year is designated by the calendar year in which it ends. Therefore, the 2000 water year ends on September 30, 2000. (2) Any twelve-month period used as a basis for hydrologic data. In the United States, the period beginning October 1 and ending September 30.

Water Yield — Runoff, including groundwater outflow that appears in the stream, plus groundwater outflow that leaves the basin underground. Water yield is the *Precipitation* minus the *Evapotranspiration*. Also referred to *Runout*.

Waterbody — A waterbody is any area that in a normal year has water flowing or standing above ground to the extent that evidence of an ordinary high water mark is established. *Wetlands* contiguous to the waterbody are considered part of the waterbody.

Waterborne — (1) Floating on or supported by water, as, for example, afloat. (2) Transported or carried by water, for example, a disease transmitted by water contaminated by a disease-causing microorganism. (3) Transmitted in water.

Waterborne Disease Outbreak — (1) The significant occurrence of acute infection illness associated with drinking water from a *Public Water System (PWS)* that is deficient in treatment, as determined by appropriate local or state agencies, or from untreated water sources. (2) The significant occurrence of acute infectious illness, epidemiologically associated with the ingestion of water from a public water system that is deficient in treatment, as determined by the appropriate local or state agency.

Waterborne Diseases — The following table lists the primary waterborne diseases by organism, source and symptom.

Waterborne Diseases	Causative Organism	Source of Organism in Water	Symptom(s)
Gastroenteritis	Rotavirus	Human feces	Acute diarrhea or vomiting
	<i>Salmonella</i> (bacterium)	Animal or human feces	Acute diarrhea and vomiting
	Enteropathogenic <i>E. Coli</i>	Human feces	Acute diarrhea or vomiting
Typhoid	<i>Salmonella typhosa</i> (bacterium)	Human feces	Inflamed intestine, enlarged spleen, high temperature— sometimes fatal
Dysentery	<i>Shigella</i> (bacterium)	Human feces	Diarrhea—rarely fatal
Cholera	<i>Vibrio comma</i> (bacterium)	Human feces	Vomiting, severe diarrhea, rapid dehydration, mineral loss—high mortality
Infectious hepatitis	Hepatitis A (virus)	Human feces, shellfish grown in polluted waters	Yellowed skin, enlarged liver, abdominal pain—low mortality, lasts up to 4 months
Amoebic dysentery	<i>Entamoeba histolytica</i> (protozoan)	Human feces	Mild diarrhea, chronic dysentery
Giardiasis	<i>Giardia lamblia</i> (protozoan)	Animal or human feces	Diarrhea, cramps, nausea, and general weakness—not fatal, lasts 1 week to 30 weeks
Cryptosporidiosis	<i>Cryptosporidium</i> (protozoan)	Animal or human feces	Diarrhea, stomach pain—lasts an average of 5 days

Watercourse — (1) A natural or artificial channel through which water flows or may flow intermittently or continuously. (2) Any stream or current of water. (3) A depression formed by runoff moving over the surface of the earth; any natural or artificial channel through which water flows; a lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourses include specifically designated areas in which substantial flood damage may occur.

Watercourse Bed — That portion of the watercourse which carries water at ordinary stages.

Watercraft — (Nautical) A boat or ship; water vehicles considered as a group.

Waterfall — A place in a stream where the course is interrupted suddenly, causing the water to descend more or less vertically without support for a significant distance.

Waterhole — A small natural depression that contains water, especially in an arid or semiarid region.

Watering Place — (1) A place where animals find water to drink; a watering hole. (2) A health resort with mineral springs; a spa.

Watering Point — A central source from which people without piped water can draw drinking water and transport it to their homes.

Waterer — (1) A person who obtains or supplies drinking water. (2) A device used for supplying water to livestock and poultry. Also referred to as *Drinker*.

Waterfall — A sudden, nearly vertical drop in a stream, as it flows over rock.

Waterfall Lake — See *Plunge Pool*.

Waterflood — The process of waterflooding an oil well; to pump water into the ground around an oil well nearing depletion in order to loosen and force out additional oil.

Waterfront — (1) Land abutting a body of water. (2) The part of a town or city that abuts water, especially a district of wharves where ships dock.

Waterish — Resembling water; watery.

Waterless — (1) Lacking water; dry. (2) Not requiring water, as a cooling system.

Waterline (or Water Line) — (1) See *Water Table*. (2) (Geology) The temporal line of contact, at any given time, between the land and any body of standing water. See *Shoreline*. (3) (Naval Architecture) The vertical level at which a vessel floats, or a horizontal line or lines on the hull indicating the level and trim at which a vessel should float under various loading conditions.

Waterlog, also Waterlogged, Waterlogging — (1) To soak or saturate with water. (2) A soil condition in which a high or perched water table is detrimental to plant growth, resulting from over-irrigation, seepage, or inadequate drainage. Also, the replacement of most of the soil air by water. (3) (Nautical) To make heavy and sluggish in the water because of flooding, as in the hold of a ship.

Waterman — (1) A man who makes his living from the water (as by fishing). (2) A boatman who plies for hire, usually on inland waters or harbors.

Watermark — (1) A mark showing the greatest height to which water has risen. (2) A line indicating the heights of high and low tide.

Watermaster — See *Water Master*.

Watermaster-Reported Headgate Deliveries — The watermaster-reported, measured and/or estimated farm headgate deliveries.

Waterpower — (1) The energy produced by running or falling water that is used for driving machinery, especially for generating electricity; (2) A source of such energy, as a waterfall. (3) A water right owned by a mill.

Waterproof — (1) Impervious to or unaffected by water. (2) Made of or coated or treated with rubber, plastic, or a sealing agent to prevent penetration by water. Also see *Water-Repellent*.

“Waters of the State” (Defined) [Nevada] — (Nevada Revised Statutes 445A.415) Means all waters situated wholly or partly within or bordering upon the State of Nevada, including, but not limited to: (1) All streams, lakes, ponds, impounding reservoirs, marshes, water courses, waterways, wells, springs, irrigation systems and drainage systems; and (2) All bodies or accumulations of water, surface and underground, natural or artificial.

Waters of the United States [33 CFR 328.3(a)] — (1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide. (2) All interstate waters including interstate wetlands. (3) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters: (a) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or (b) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (c) Which are used or could be used for industrial purpose by industries in interstate commerce. (4) All impoundments of waters otherwise defined as waters of the United States under the definition. (5) Tributaries of waters identified in (1) through (4), above. (6) The territorial seas. (7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in (1) through (6), above. Waters of the United States do not include prior converted cropland. Also, waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of Clean Water Act (CWA) (other than cooling ponds as defined in 40 Code of Federal Regulations 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

Watershed — (1) The total land area that from which water drains or flows to a river, stream, lake or other body of water. (2) The geographical land area that drains into a stream or a particular receiving water body. The point of high ground dividing two different drainage systems. (3) The region drained by a specific water system. (4) An area of land that contributes runoff to one specific delivery point; large watersheds may be composed of several smaller “subsheds” (e.g., hydrographic areas and/or sub-areas), each of which contributes runoff to different locations that ultimately combine at a common delivery point. (5) An area that, because of topographic slope, contributes water to a specified surface water drainage system, such as a stream or river. An area confined by topographic divides that drains a given stream or river. (6) (Catchment) The natural or disturbed unit of land on which all of the water that falls (or emanates from springs or melts from snowpacks), collects by gravity, and fails to evaporate, runs off via a common outlet. (7) All lands enclosed by a continuous hydrologic drainage divide and lying upslope from a specified point on a stream; a region or area bounded peripherally by a water parting and draining ultimately to a particular water course or body of water. Also referred to as *Water Basin* or *Drainage Basin*. (8) A ridge of relatively high land dividing two areas that are drained by different river systems. Also referred to as *Water Parting*. (9) (Forestry) A forest that serves as a source of water for rivers and streams by soaking up rain and melted snow in its soil.

Watershed Approach — See *Watershed Protection Approach (WPA) [EPA]*.

Watershed Area (Drainage Area) — The watershed area at a point in the stream refers to the area of the earth from which the water concentrates toward that point, through the drainage system.

Watershed Information Network (WIN) [OWOW/EPA] — In partnership with others, the *Office of Wetlands, Oceans, and Watersheds (OWOW)*, U.S. Environmental Protection Agency (EPA), operates the Internet-based Watershed Information Network. WIN is a roadmap to consolidated watershed information and services that can help communities protect and restore water quality. WIN provides ready access to information on such topics as: (a) what a watershed is, (b) how to find a specific watershed, (c) available training for watershed practitioners, and (d) financing watershed protection and restoration activities. Included in WIN is the Index of Watershed Indicators, which compiles information on the health of aquatic resources in over 2,100 watersheds in the 48 contiguous states. Entering a “place” (such as ZIP code, county, tribe, or school) in WIN will generate specific data about a watershed and show the user how they can get involved in watershed issues. Individuals can access WIN at www.cleanwater.gov/win. OWOW has modernized EPA’s computerized STORage and RETreival system for water quality data, STORET, so that it more effectively meets the emerging information needs for watershed protection. New STORET will serve as EPA’s principal repository for chemical data, biological community information, fish tissue analyses, and aquatic habitat evaluations for fresh and marine water. PC-based and user-friendly, new STORET requires quality assurance information to ensure the integrity of the data in the system. Data in new STORET will soon be accessible via the Internet. OWOW is also developing a variety of tools to help states and other partners geographically display and manage their water information.

OWOW's Watershed Information Network provides consolidated watershed information and services that can help communities protect and restore water quality.

Watershed Lag — The time from the center of mass of effective rainfall to the peak of the hydrograph.

Watershed Management — (1) The planned manipulation of one or more factors of the natural or disturbed drainage so as to effect a desired change in or maintain a desired condition of the water resource. (2) The analysis, protection, development, operation or maintenance of the land, vegetation and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents. Watershed management for water production is concerned with the quality and timing of the water which is produced. Also referred to as *Water Management* and *Basin Management*.

Watershed Management Initiative (WMI) [California] — The Watershed Management Initiative was developed in the State of California in response to recommendations from (1) the State's Water Resources Control Board's Strategic Plan, (2) Technical Advisory Committee reports to the State Water Resources Control Board on improving nonpoint source management, and (3) recommendations of the Inland Surface Waters Plan's Watershed Task Force. A key component of the WMI is the prioritization of water quality issues. Specifically, each Regional Water Quality Control Board develops a Watershed Management Initiative "Chapter," which is a staff-level planning document outlining the priority watershed within that region, the water quality problems in the region, and actions being taken to address water quality. The Chapter allocates time and resources to water quality issues according to management priorities. The State Water Resources Control Board, each Regional Water Quality Control Board, and the *U.S. Environmental Protection Agency (EPA)*, through the WMI, are pursuing the following goals:

- [1] Encourage and practice comprehensive natural resource stewardship that is balanced with economic and other interests;
- [2] Promote voluntary, collaborative decision-making at the local level that is open to all stakeholders and seeks to identify compatible interests;
- [3] Integrate point source regulatory programs, nonpoint source programs, and other resource management programs on a watershed basis to promote effectiveness and efficiency; and
- [4] Give more emphasis to reducing the impact of nonpoint sources.

Watershed Planning — The formulation of a plan, based on the concept of a *Watershed*, a *Water Basin*, a *Hydrologic Region*, or a *Hydrologic Study Area (HSA)*, with the intent to assess climatological conditions, inventory existing ground and surface water resources, determine current water uses, project future socioeconomic and environmental demands for those resources, and explore feasible water-balancing options, so as to maximize the benefits to the inhabitants of a study area while simultaneously preserving and protecting the region's wildlife, habitat, and environmental conditions.

Watershed Project — (1) A comprehensive program of structural and nonstructural measures to preserve or restore a water shed to good hydrologic condition. These measures may include detention reservoirs, dikes, channels, contour trenches, terraces, furrows, gully plugs, revegetation, and possibly other practices to reduce flood peaks and sediment production. (2) A group of activities undertaken in a geographic area to restore and/or maintain beneficial uses of a waterbody already affected, degraded, or threatened by point and nonpoint source (NPS) pollution. These activities may include, but not be limited to, *Source Water Assessments* and protection, storm water management, implementation of *Best Management Practices*, involvement of interested *Stakeholders*, collection of analytical data, or development of *Total Maximum Daily Loads*.

Watershed Protection — The treatment of watershed lands in accordance with such predetermined objectives as the control of erosion, stream flow, silting floods, and water, forage, or timber yield. Also see *Watershed Planning*.

Watershed Protection Approach (WPA) [OW/EPA] — A strategy supported by the *U.S. Environmental Protection Agency (EPA)*, *Office of Water (OW)*, which is used as a strategy for effectively protecting and restoring aquatic ecosystems and protecting human health. This strategy has as its premise that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual waterbody or discharger level. The watershed approach is a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically-defined geographic areas, taking into consideration both ground and surface water flow. Major features of a Watershed Protection Approach are: (a) targeting priority problems; (b) promoting a high level of stakeholder involvement; (c) integrated solutions that make use of the expertise and authority of multiple agencies; and (d) measuring success through monitoring and other data gathering. The Watershed Protection Approach is composed of three key component parts:

- [1] **Geographic Focus** – Watersheds are nature's boundaries. They are the areas that drain to surface water bodies. A watershed generally includes lakes, rivers, estuaries, wetlands, streams, and the surrounding landscape. Groundwater recharge areas are also considered.
- [2] **Continuous Improvement Based on Sound Science** – Sound scientific data, tools, and techniques are critical to inform the process. Actions taken include characterizing priority watershed problems and solutions, developing action plans and evaluating their effectiveness within the watershed.
- [3] **Partnerships and Stakeholder Involvement** – Watersheds transcend political, social, and economic boundaries. Therefore, it is important to involve all the affected interests in designing and implementing goals for the watershed. Watershed teams may include representatives from all levels of government, public interest groups, industry,

academic institutions, private landowners, concerned citizens and others.

The WPA is a “placed-based” strategy that integrates water quality management activities within hydrologically defined drainage basins or watersheds as opposed to using conventional, politically-defined boundaries. The WPA allows stakeholders to tailor corrective actions to local concerns within the coordinated framework of a state, Tribal, and national water program. In addition, an emphasis on public participation provides the opportunity to incorporate environmental justice issues into watershed management. Six basic objectives form the general foundations of EPA’s watershed protection process:

- [1] Identifying critical watersheds with EPA and state participation;
- [2] Clearly defining the problems, general causes, and specific sources of risks and impairments to the watershed;
- [3] Developing potential pollution prevention and control strategies;
- [4] Implementing point and nonpoint source controls;
- [5] Developing scientifically valid and practical indicators for gauging and reducing the risks in the watershed; and
- [6] Developing ecological criteria that states may use in formulating future watershed protection standards.

Waterside — (1) Land bordering a body of water; a bank or shore. (2) The margin of a body of water; a *Waterfront*.

Waterspout — (1) A tornado or lesser whirlwind occurring over water and resulting in a funnel-shaped whirling column of air and spray. (2) A hole or pipe from which water is discharged.

Waterstop — A strip of metal, rubber, or other material used to prevent leakage through joints between adjacent sections of concrete.

Watertight — So tightly made that water cannot enter or escape.

Waterway — (Nautical) A navigable body of water, such as a river, channel, or canal.

Waterwall Incinerator — An energy recovery system used in some municipal waste incinerators. The combustion chamber of the incinerator is lined with steel tubes containing circulating water. The heat from the combustion boils the water, and the steam can be sold or used to turn turbines in an electric generator.

Waterworn — Worn, smoothed, or polished by the action of water.

Waterworks — (1) The water system, including reservoirs, tanks, buildings, pumps, and pipes, that supplies water to a city, town, or other municipality. A single unit, such as a pumping station, within such a system. (2) An exhibition of moving water, such as a fountain or cascade.

Watery — (1) Filled with, consisting of, or soaked with water; wet or soggy. (2) Containing too much water.

Watt — A unit of power or the rate of energy use or conversion when one joule of energy (0.0238 calories) is used or converted per second.

Watt-Hour (Wh) — An electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electrical circuit steadily for one hour.

Wave — A regular movement on a surface or within a material when energy travels through it. On the surface of an ocean or body of water, it is usually in the form of a curving swell or ridge.

WAVE — See *Water Alliances for Voluntary Efficiency (WAVE)*.

Wave Attack — The impact of waves on a stream bank.

Wave Base — The depth of water beyond which suspended sediments are not agitated by wave action.

Wave-Built Terrace — (Geology) A gently sloping surface built up at the seaward margin of a wave-cut platform from sediments that drifted along the shore or across the platform and were deposited in the deeper water beyond.

Wave Celerity — The velocity of propagation of a wave through a liquid, relative to the rate of movement of the liquid through which the disturbance is propagated.

Wave-Cut Bench — (Geology) A level or slightly inclined erosional surface or platform that is carved by the action of waves and projects outward from the base of a sea cliff. Also referred to as a *Beach Platform* or *High-Water Platform*.

Wave-Cut Cliff — (Geology) A cliff formed along a coast by the action of waves cutting horizontally and landward into rock.

Wave-Cut Notch — (Geology) A small, V-shaped depression cut out at the base of a sea cliff by the erosive action of waves.

Wave Cut Platform — (Geology) A gently sloping surface produced by wave erosion, extending far into the sea or lake from the base of the *Wave-Cut Cliff*. Also referred to as a *Wave-Cut Terrace* or *Wave-Cut Plain*.

Wave-Cut Terraces — A characteristic remnant of immense *Pluvial Lakes* such as *Lake Lahontan* and *Lake Bonneville*. These terraces are formed through an erosional-depositional process that occurs in two main stages. The first stage is the formation of what is known as a terrace tread. A terrace tread is the horizontal component of a wave-cut terrace. The terrace tread is formed during a long period of consistent water levels in which waves continually erode and deposit material to form a gently-sloping horizontal surface. This process continues until the lake undergoes a uniform drop in lake level. The second stage of terrace formation occurs during and after this drop in water level. While the water level is dropping, the waves begin to erode a portion of the terrace tread, which over time begins to create a nearly vertical wall, called a terrace riser. The terrace riser is completely formed once the lake level has stopped subsiding, in which case another terrace tread begins to form, and the process is started over again. The end result is a series of terrace treads and risers that show the slow declination of the water level.

Wave Machine — A device used for converting the energy of ocean waves into electrical energy. It can also make waves at a water recreation site for swimming or surfing.

Wave Periods — (Oceanography) Wind generates waves that have a wide range of periods; it is responsible for pure capillary waves (ripples), which have periods less than 0.1 second, and for most gravity waves, which have periods from 0.1 second to approximately 30 seconds. Wind-driven gravity waves contain, on the average, more energy than waves of any other period. Seas (waves being actively generated by the wind during a storm) have periods of 4-10 seconds, and swells (waves that have radiated from the wind storm) have periods of 10-30 seconds. Wind storms are also responsible for waves with periods longer than 30 seconds; these storms excite *Seiches* (standing waves that do not move forward but instead move up and down) whose typical periods range from 5-10 minutes, and storm surges (large waves having periods from 1-100 hours).

Wave System — (Oceanography) A group of waves of similar height, direction, and length; generally, ocean waves consist of several superimposed wave systems.

Weather — The composite condition of the near earth atmosphere, which includes temperature, barometric pressure, wind, humidity, clouds, and precipitation. Weather variations over a long period create the *Climate*.

Weather Conditions [NWS] — See (*Weather Conditions*) *Cloud Cover [NWS]*.

Weather Modification — (1) The term “weather modification” means performing any activity with the intention of producing artificial changes in the composition, behavior, or dynamics of the atmosphere. (2) The intentional or inadvertent alteration of clouds for the benefit of man. Also referred to as *Cloud Modification*. Also see *Cloud Seeding*.

Weather Pit — (Geology) A small, shallow indentation on the generally flat summit of exposed granite or granitic rocks formed by the intense, local solvent action of impounded water.

Weathering — (Geology) (1) The physical disintegration or chemical decomposition of rock due to wind, rain, heat, freezing, thawing, etc. (2) The *in-situ* physical disintegration and chemical decomposition of rock materials at or near the Earth’s surface. (3) The natural processes by which the actions of atmospheric and other environmental agents, such as wind, rain, and temperature changes, result in the physical disintegration and chemical decomposition of rocks and earth materials in place, with little or no transport of the loosened or altered material. (4) The response of materials that were once in equilibrium within the earth’s crust to new conditions at or near contact with water, air, or living matter. The breakdown of rock through a combination of chemical, physical, geological, and biological processes. The ultimate outcome is the generation of soil. Also referred to as *Demorphism* or *Clastation*.

Wedge Storage — The volume of water contained between two different water surface profiles within a canal pool.

Weep-Hole (Weephole) — (Engineering) (1) Opening left in a revetment, bulkhead, or wall to allow groundwater drainage. (2) Openings left in retaining walls, aprons, linings, or foundations to permit drainage and reduce pressure. A hole (as in a wall or foundation) that is designed to drain off accumulated water. Also referred to as *Weeper*.

Weeper — A hole or pipe in a wall to allow water to run off.

Weeping — Dropping rain as in weeping clouds.

Weeping Spring — See *Seepage Spring*.

Weighted Average — (1) (Data Analysis) For a series of recorded observations, the sum of the products of the frequency of certain values and the value of the observation, divided by the total number of observations. For example, for one measurement of 5 grams, three measurements of 7 grams, and two measurements of 2 grams, the weighted average is $[1(5) + 3(7) + 2(2)]/6 = 5$ grams. (2) (USGS) Used to indicate discharge-weighted average. It is computed by multiplying the discharge for a sampling period by the concentrations of individual constituents for the corresponding period and dividing the sum of the products by the sum of the discharges. A discharge-weighted average approximates the composition of water that would be found in a reservoir containing all the water passing a given location during the water year after thorough mixing in the reservoir.

Weir — (1) A barrier placed in a channel to divert fish or water. (2) A dam in a river to stop and raise the water, for the purpose of conducting it to a mill, forming a fishpond, or the like. When uncontrolled, the weir is termed a fixed-crest weir. (3) A fence of stakes, brushwood, or the like, set in a stream, tideway, or inlet of the sea, for taking fish. (4) A device for determining the quantity of water flowing over it from measurements of the depth of water over the crest or sill and known dimensions of the device. (5) A bank or levee built to hold a river in its bed, or to direct it into a new bed. (6) (Water Quality) A wall or obstruction used to control the flow from settling tanks and clarifiers to assure a uniform flow rate and avoid *Short-Circuiting*. Types of weirs include:

- [1] Broad-crested;
- [2] Sharp-crested;
- [3] Drowned; and
- [4] Submerged.

Weir Basin — (Irrigation) The wide, basinlike approach to the upstream side of a weir, being constructed so as to reduce to a minimum the effect of the momentum of the approaching water on the flow over the weir.

Weir Box — (Irrigation) (1) A device to measure and/or control surface water flows in streams or between a series of ponds. (2) A wooden or concrete box oblong in shape and open at both ends, set lengthwise in a canal and in which a *Weir* for measurement of irrigation water is set cross-wise.

Weir Diameter — Many circular clarifiers have a circular weir within the outside edge of the clarifier. All the water leaving the clarifier flows over this weir. The diameter of the weir is the length of a line from one edge of a weir to the opposite edge and

passing through the center of the circle formed by the weir.

Weir Loading — A guideline used to determine the length of weir needed on settling tanks and clarifiers in treatment plants. Used by operators to determine if weirs are hydraulically (flow) overloaded.

Weir Loading Rate — An expression of the flow over a weir calculated by dividing the flow by the total effluent weir length. Typical units are gallons per minute per foot (GPM/ft) or gallons per day per foot (GPD/ft).

Weir Notch — The opening in a weir for the passage of water.

Well (Water) — (1) A bored, drilled, or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground. (2) An excavation (pit, hole, tunnel), generally cylindrical in form and often walled in, drilled, dug, driven, bored, or jetted into the ground to such a depth as to penetrate water-yielding geologic material and allow the water to flow or to be pumped to the surface. (3) An artificial excavation or opening in the ground, made by means of digging, boring, drilling, jetting, or by any other artificial method, for the purpose of obtaining groundwater. Any series of openings, borings, or drillings developed and pumped collectively by a single pump unit shall be considered as one well. (4) An artificial excavation put down by any method for the purposes of withdrawing water from the underground aquifers. A bored, drilled, or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground.

Well Capacity (or Potential Yield) — The maximum rate at which a well will yield water under a stipulated set of conditions, such as a given drawdown, pump, and motor or engine size. Well capacity may be expressed in terms of gallons per minute, cubic feet per second, or other similar units.

Well Development — The application of a surging or brushing process to a well in order to draw fine material from the aquifer next to the well and increase its discharge capacity.

Well Drillers — (1) Any person or persons engaged in the commercial drilling or construction, redrilling, and rebuilding of wells in a state. (2) Individuals who have the equipment and ability to drill or dig wells. Typically, such individuals must be licensed by state water resource agencies and are required to submit certain documents (*Water Well Reports* or *Well Logs*) pertaining to their operations.

Well Field — (1) One or more wells producing water from a subsurface source. Area containing one or more wells that produces usable amount of water. (2) A tract of land which contains a number of wells for supplying a large municipality or irrigation district.

Well, Fully Penetrating — A well drilled to the bottom of an aquifer, constructed in such a way that it withdraws water from the entire thickness of the aquifer.

Well Function — The mathematical function by means of which the unsteady drawdown can be computed at a given point in an aquifer at a given time due to a given constant rate of pumping from a well.

Well Hydrograph — A graphic representation of the fluctuations of the water surface in a well, plotted as *Ordinate*, against time, plotted as *Abscissa*.

Well Injection — The subsurface emplacement of fluids into a well.

Well Interference — The effects of neighboring pumping wells on the discharge and drawdown at a particular pumping well.

Well Isolation Zone — The surface or zone surrounding a water well or well field, supplying a public water system, with restricted land uses to prevent contaminants from a not permitted land use to move toward and reach such water well or well field. Also see *Wellhead Protection Area (WHPA)*.

Well Logs — A record that is kept during well drilling of the various formations and rock materials and the depths at which they are encountered. Synonymous with *Water Well Report*.

Well Monitoring — Measurement by on-site instruments or laboratory methods of well water quality.

Well Plug — Any watertight or gas-tight seal installed in a well to prevent the flow of fluids or gases.

Well Point — (1) A screening device, equipped with a point on one end, that is meant to be driven into the ground. (2) A hollow, pointed rod with a perforated (containing many small holes) tip. A well point is driven into an excavation where water seeps into the tip and is pumped out of the area. Used to lower the water table and reduce flooding during an excavation.

Well Rehabilitation — Restoration of a well to beneficial use by recasing, rebuilding, repairing, and resealing the well to provide for continued use of the well as a water supply, but not cleaning, acidizing, pump removal, or pump repair by itself.

Well Rig — Any power-driven percussion, rotary, boring, digging, jetting or auguring machine used in the construction of a well.

Well Screen — (1) A filtering device used to keep sediment from entering a water well. (2) The intake structure of a well which allows water to enter the well and which helps prevent formation material from entering with the water.

Well Stimulation — Cleaning, enlarging, or increasing the pore space of a well used for the *Injection* of fluids into subsurface geological strata.

Well Yield — The volume of water discharged from a well in gallons per minute or cubic meters per day.

Wellhead — (1) The source of a well or stream. (2) A principal source; a *Fountainhead*. (3) The source of a stream or the place where a spring emerges from the ground. (4) The top level of a well, from which water pumped from the well is allowed to flow freely. (5) The physical structure, facility, or device at the land surface from or through which groundwater flows or is pumped

from subsurface, water-bearing formations.

Wellhead Protection Area (WHPA) — The surface and subsurface area surrounding a water well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field. Also see *Well Isolation Zone*.

Wellhead Protection (Program) — Programs intended to protect and preserve the quality of groundwater used as a source of drinking water. A typical wellhead protection program will have a number of critical elements to include: (a) delineating the roles and responsibilities of state agencies, local governments, and water purveyors; (b) delineation of wellhead protection areas; (c) contaminant source inventories; (d) management options; (e) siting of new wells; (f) contingency and emergency planning; and (g) public participation. Typically, steps taken to protect and preserve the quality of a well are far less costly than actions necessary to restore a contaminated well.

Wellhead Treatment — Water quality treatment of water being produced at the well site.

Wellspring — The source of a stream or spring.

Westside (USBR) — The 17 Western States in which U.S. Bureau of Reclamation (USBR) projects are located, namely, Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

Westward Intensification — (Oceanography) A hypothetical explanation of the intensification of currents on the western sides of the oceans, derived from a mathematical model of the effects of internal friction and zonal wind stress at the surface.

Wet — Consisting of, containing, covered with, or soaked with, water or other liquid; soaked with moisture; having water or other liquid upon the surface.

(Project) WET — See *Water Education for Teachers (Project WET) [Nevada]*.

Wet Adiabatic Lapse Rate — The rate of temperature decrease as a parcel of air saturated with water rises and the pressure decreases, given by:

$$\gamma_s = -dT/dz$$

where:

dT is the temperature change;

dz is the change in altitude; and

γ_s is the saturated (wet) *Adiabatic Lapse Rate*.

Because moisture is condensing in the rising parcel of air and releasing latent heat, the temperature drop with increasing altitude is less than the (dry) adiabatic lapse rate, or about 0.6EC per 100 meters (3.3EF per 1,000 feet). The rate assumes that there is no exchange of heat between the parcel and the surrounding air by conduction or mixing.

Wet Bulb Temperature — The temperature attained by a thermometer when surrounded by a moistened wick in the air stream. It is useful in determining atmospheric humidity.

Wet Chemistry — Laboratory procedures used to analyze a sample of water using liquid chemical solutions (wet) instead of, or in addition to, laboratory instruments.

Wet Cooling — A type of cooling system which uses the evaporation of water to help dissipate excess heat. The devices used to effect this are more commonly referred to as “swamp coolers.”

Wet Deposition — The introduction of acidic material to the ground or to surface waters by sulfuric and nitric acids dissolved in rainfall or snow. Compare to *Dry Deposition*.

Wet Digestion — A solid waste stabilization process in which mixed solid organic wastes are placed in an open digestion pond to decompose anaerobically.

Wet Floodproofing — Protecting a building by allowing flood waters to enter so that internal and external hydrostatic pressures are equalized. Usually, only enclosed areas used for parking, storage, or building access are wet floodproofed. Contrast with *Dry Floodproofing*.

Wet Line — The length of sounding line below the water surface.

Wet Mass — The mass of living matter plus contained water.

Wet Meadow — Grassland with waterlogged soil near the surface but without standing water for most of the year.

Wet Microburst — a microburst accompanied by heavy precipitation at the surface.

Wet Milling — The mechanical size reduction of solid wastes that have been wetted to soften the paper and cardboard constituents.

WET, Nevada Project — See *Water Education for Teachers (Project WET) [Nevada]*.

Wet Oxidation — (Wastewater Treatment) A method of treating or conditioning sludge before the water is removed. Compressed air is blown into the liquid sludge. The air and sludge mixture is fed into a pressure vessel where the organic material is stabilized. The stabilized organic material and inert (inorganic) solids are then separated from the pressure vessel effluent by *Dewatering* in lagoons or by mechanical means.

Wet Pack — A therapeutic pack moistened in hot or cold water.

Wet Scrubber — An air cleaning device that literally washes out the dust. Exhaust air is forced into a spray chamber, where fine

water particles cause the dust to drop from the air stream. The dust-laden water is then treated to remove the solid material and is often recirculated.

Wet Scrubbing — A process that removes particles, gases, or vapors from an exhaust gas by passing the exhaust through a shower of water or water that contains an agent to react with the material to be removed.

Wet-Snow Avalanche — One of the basic types of snow avalanche, caused by a sudden thaw that releases a large mass of wet, heavy snow; it is also the slowest moving type of avalanche. Also referred to as a *Slush Avalanche*.

Wet Suit — (1) A tight-fitting permeable suit worn in cold water, as by skin divers, to retain body heat. (2) A close-fitting garment of neoprene foam that provides thermal insulation in cold water. Unlike a *Dry Suit*, a wet suit allows limited water absorption so that the body can warm the water closest to it. Dry suits are more appropriate for extremely cold water.

Wet Weight — The weight of animal tissue or other substances including its contained water.

Wet Well — (Wastewater Treatment) A compartment or tank in which wastewater is collected. The suction pipe of a pump may be connected to the wet well or a submersible pump may be located in the wet well.

Wetland (or Wetlands) — (1) An area that is periodically inundated or saturated by surface or groundwater on an annual or seasonal basis, that displays hydric soils, and that typically supports or is capable of supporting hydrophytic vegetation. (2) Any number of tidal and non-tidal areas characterized by saturated or nearly saturated soils most of the year that form an interface between terrestrial (land-based) and aquatic environments; include freshwater marshes around ponds and channels (rivers and streams), brackish and salt marshes; other common names include swamps and bogs. Also see *Wetlands*. (3) Wetlands are those areas where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment. (4) (Ecology) Any section of low-lying land that is periodically submerged or whose soil contains a great deal of moisture. The identification of wetlands and associated habitats is regulated by complex federal legislation. The U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (COE), the (U.S. Department of Agriculture) *Natural Resources Conservation Service (NRCS)*, and the (Department of the Interior) *U.S. Fish and Wildlife Service (USFWS)*, have developed definitions of wetlands in response to their regulatory responsibilities. The single feature that all wetlands have in common is a soil or substrate that is saturated with water during at least a part of the growing season. These saturated conditions control the types of plants and animals that live in these areas. Other common names for wetlands are *Sloughs*, *Ponds*, *Swamps*, *Bogs*, and *Marshes*. Basically, all definitions of wetlands require that one or more attributes be met:

- [1] **Wetland Hydrology** – At some point of time in the growing season the substrate is periodically or permanently saturated with or covered by water;
- [2] **Hydrophytic Vegetation** – At least periodically, the land supports predominantly water-loving plants such as cattails, rushes, or sedges;
- [3] **Hydric Soils** – The area contains undrained, wet soil which is anaerobic, or lacks oxygen in the upper levels.

In general, wetlands are the bogs, swamps, estuaries, and marshes connected to streams, groundwater, rivers, lakes, and coastlines. Wetlands are semi-aquatic links in a water-based chain extending from stream sources to their ultimate destinations. While wetlands have characteristics of aquatic and terrestrial ecosystems, they are, in fact, neither of these. They form their own unique systems, which typically include specific types of soils supporting plants adapted to the soils and a watery environment. Despite their name, wetlands are not always wet, though characteristically, they experience period saturation. Wetlands can be permanent or seasonal. Permanent wetlands tend to stay saturated with water, and in the case of tidal wetlands, they are flooded or drained twice each day. Seasonal wetlands, such as tule fields and vernal pools, experience saturation or flooding only part of the year. Even though water may be present only a few weeks out of every year, seasonal wetlands nonetheless share with permanent wetlands the soils, plants, and animal life characteristics of “wetlands.” Another classification divides wetlands into those associated with oceans (marine and estuarine), lakes (lacustrine), rivers and streams (riverine), and those found in inland areas including marshes, swamps, and bogs (palustrine). Freshwater marshes occur in ponds and slow moving streams vegetated with cattails, sedges, and rushes. Riparian wetlands, noted for their woody vegetation, occur on the banks of streams, rivers, and lakes. Bogs have peat soils composed of peat and are vegetated mostly with mosses. Vernal pools form unique, short-lived ecosystems in shallow depressions in the spring. Also see *Wetlands*, *Wetlands (COE and EPA)*, *Wetlands (NRCS)*, *Wetlands (USFWS)*, *Wetlands [California]*, *Wetlands [Nevada]*, and *Wetlands and Deepwater Habitats Classification System (USFWS)*.

Wetland [IWLA] — A wetland can be as small as a backyard pond or as large as the *Everglades* and they are found on every continent except Antarctica and in every state in the United States. The primary characteristic that sets wetlands apart from other features of the landscape is that they are wet. However, there are many different legal and scientific definitions of wetlands that cover their other characteristics. Wetlands are generally defined as vegetated areas that are covered with water or have very wet soils for part of the year. Wetlands do not exist in isolation, but are instead a part of an extensive interconnected system of land and water called a watershed. A watershed is the area of land that drains to a particular body of water such as a river, lake, or wetland. In addition to being part of a watershed, wetlands are connected to every natural habitat including streams, lakes, forests, and meadows. Wetlands even are linked to the atmosphere through the hydrologic cycle. Rain enters wetlands directly or through lakes, streams, and groundwater. Wetlands help regulate the hydrologic cycle by holding rainwater and slowly releasing it back into streams and lakes, ensuring that fish have a constant and steady water supply.

Wetland Allocation or Replacement — These terms apply to activities in which most or all of an existing wetland is converted to a different type of wetland. For example, changing an emergent wetland to a pond converts the habitat from one wetland type to something quite different.

Wetland Banking — A term used to describe actions required to be taken on the part of developers to mitigate and replace the loss of wetlands. Through various federal and state regulations governing land use on wetlands, when impacts to wetlands cannot be avoided or minimized, wetlands must be replaced. The replacement process allows for the creation or restoration of any number of wetlands to provide replacement credit for future wetlands impacts or debits, i.e., reductions in existing wetlands. Wetland banking not only insures successful wetland restoration, but also typically requires that replacement occurs before targeted wetlands are removed, thereby at least temporarily increasing the overall amount of wetlands. Also, wetland banking credits may frequently be sold in an open market arrangement thereby facilitating both more efficient land use planning and habitat preservation. Wetland creation under the wetland banking process also allows planners to target wetland construction in precisely those areas and watersheds which have the greatest need for the benefits of wetlands, e.g., flood storage, water quality improvement, habitat creation or preservation, etc. Also see *Wetland "Clumping" (Aggregation)*, *Wetland Mitigation*, *Wetland Mitigation Bank*, *Wetlands (General Definition)*, *Wetlands (COE and EPA)*, *Wetlands (NRCS)*, *Wetlands (USFWS)*, *Wetlands [California]*, *Wetlands [Nevada]*, *Wetlands, Benefits*, and *Wetlands, Palustrine*.

Wetland Center — See *Duke University Wetland Center*.

Wetland "Clumping" (Aggregation) — The concept of wetland "clumping", or wetland aggregation, constitutes a fundamental issue of *Wetland Banking* programs and generally occurs when several small, fragmented wetlands, providing unique and specific benefits to a localized ecosystem, are destroyed and then, through the wetland banking process, their removal is compensated for by the creation of a single larger wetland, perhaps at some distance from those wetland which were removed. This concept of wetland aggregation does not take into account the relatively unique geographic functions that localized wetlands provide to a watershed and the needs of both plant and animal life specific to that habitat. Studies have shown that increasing the distances between the destroyed wetlands and the newly created wetlands has been a major reason for population declines in certain species. Currently, wetland rules are being considered to encourage the development of smaller, more numerous wetlands as part of a more responsive wetland banking mitigation and replacement program. Also see *Wetlands (General Definition)*, *Wetlands (COE and EPA)*, *Wetlands (NRCS)*, *Wetlands (USFWS)*, *Wetlands [California]*, *Wetlands [Nevada]*, *Wetlands, Benefits*, and *Wetlands, Palustrine*.

Wetland Creation — The construction of a wetland in an area that was not a wetland in the recent past (specified, for example, within the last 100-200 years) and that is isolated from existing wetlands (i.e., not directly adjacent). In other words, creation occurs when a wetland is placed on the landscape by some human activity on a non-wetland site. Typically, a wetland is created by excavation of upland soils to elevations that will support the growth of wetland species through the establishment of an appropriate hydrology. Also referred to as *Wetland Establishment*.

Wetland Degradation — The impairment of wetland functions as a result of human activity. In practice, *Wetland Loss* is rarely independent of wetland degradation, since the loss of part of a wetland area is likely to impair the functions of the remaining wetland area. Conversely, wetland degradation frequently occurs without the loss of wetland area, through upstream impacts on hydrology and water quality, etc. Generally, wetland loss is difficult and costly to reverse, although wetland restoration (i.e., the reinstatement of some, or all, pre-existing functions to "lost" wetlands) and wetland creation (the introduction of some wetland functions to formerly non-wetland areas) are increasingly popular applied sciences and conservation tools. Changes resulting from wetland degradation are more easily reversed through rehabilitation (i.e., the enhancement of the remaining functions and the reintroduction of past functions to degraded wetlands) than is wetland loss. Consequently, both wetland loss and degradation relate to the change in quantity and/or quality of the wetland resource around a baseline. See *Wetland Losses, United States*, and *Wetland Losses, International*.

Wetland Delineation — An ecological field study that locates the wetland-upland boundary on a specific piece of property. A wetland delineation requires a detailed study of the vegetation, soils, and water on the property using the methodology proscribed in the *U.S. Army Corps of Engineers (Corps) 1987 Wetland Delineation Manual*. According to requirements contained in this manual, to delineate wetlands, a base line is established perpendicular to the surface flow of water along a property boundary. A series of transects are established throughout the area such that all plant communities are intersected. Along each transect a sampling plot is located in the center of each plant community. At each sampling plot three parameters (vegetation, soils, and hydrology) are studied. A scientific determination is made whether each of the three parameters possess wetland characteristics. If all three parameters are determined to have wetland characteristics, then the sampling point is located within a wetland. If one or two of the parameters do not possess wetland characteristics, then sampling point is not a wetland and the boundary with the upland area is established. The process is continued along each transect until all wetland boundaries are located. Then, the boundaries along each transect are connected and the general wetland boundary delineated.

Wetland Enhancement — (1) The modification of specific structural features of an existing wetland to increase one or more of its functions based on management objectives, typically done by modifying site elevations or the proportion of open water. Although this term implies a gain or improvement to wetland functions, it should be noted that a positive change in one wetland function may negatively affect other wetland functions. Enhancement may also be the alteration of a site to produce conditions

that did not previously exist in order to accentuate one or more values of a site. For example, increasing the area of deep water by excavating parts of an emergent wetland may provide more waterfowl habitat (the desired wetland value), but may decrease foraging and cover habitat for young fish. (2) (U.S. Federal Agencies) The manipulation of the physical, chemical, or biological characteristics of a wetland (undisturbed or degraded) site in order to heighten, intensify, or improve specific function(s) or for a purpose such as water quality improvement, flood water retention or wildlife habitat. Enhancement results in a change in wetland function(s) and can lead to a decline in other wetland function, but does not result in a gain in wetland acres. This term includes activities commonly associated with the terms enhancement, management, manipulation, directed alteration.

Wetland Establishment — The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist on an upland or deepwater site, i.e., *Coastal Wetlands* or *Upland Wetlands*. Establishment results in a gain in wetland acres. Also referred to as *Wetland Creation*.

Wetland Functional Capacity Index (FCI) [Corps] — An index of the capacity of a wetland to perform a function relative to other wetlands within a *Regional Wetland Subclass* in a reference domain. As used in the *U.S. Army Corps of Engineers' (Corps) Hydrogeomorphic Approach* to wetland assessment and classification, the functional capacity indices are by definition scaled from 0.0 to 1.0. For example, an index of 1.0 indicates the wetland performs a function at the highest sustainable functional capacity, the level equivalent to a wetland under reference standard conditions in a reference domain. An index of 0.0 indicates the wetland does not perform the function at a measurable level, and will not recover the capacity to perform the function through natural processes.

Wetland Functions [Corps] — As used in the *U.S. Army Corps of Engineers' (Corps) Hydrogeomorphic Approach* to wetland assessment and classification, these are the normal activities or actions that occur in wetland ecosystems, or simply, the things that wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape, and their interaction.

Wetland Highest Sustainable Functional Capacity [Corps] — The level of functional capacity achieved across the spectrum of functions by a wetland under reference standard conditions in a reference domain used in the *U.S. Army Corps of Engineers' (Corps) Hydrogeomorphic Approach* to wetland assessment and classification. This approach assumes that the highest sustainable functional capacity is achieved when a wetland ecosystem and the surrounding landscape are undisturbed. Also see *Functional Capacity Index*.

Wetland, Jurisdictional — See *Jurisdictional Wetland [Corps]*.

Wetland Loss — The loss of wetland area, due to the conversion of wetland to non-wetland areas, as a result of human activity. Generally, wetland loss is difficult and costly to reverse due, in large part, to the nature of the activity that caused the loss, e.g., development activities. In industrialized countries, the consequences of the loss and degradation of wetlands have often been mitigated with expensive artificial constructions, such as major flood protection schemes or water purification plants. However, losses of wetlands in developing countries are likely to have a more direct impact than in richer countries, because mitigatory measures are less likely to be implemented due to financial and technical constraints. In addition, the consequences of wetland loss and degradation are likely to be more severe in arid and semi-arid countries because of the scarcity of wetland resources. See *Wetland Losses, United States*, and *Wetland Losses, International*. Also see *Wetland Degradation*.

Wetland Losses, International — The loss of wetlands throughout the rest of the world is little less severe than that of the United States, and typically follows the degree of human settlement and related activities. For Canada, a high level of quantitative information on losses is also available (National Wetlands Working Group 1988). Since settlement, approximately 65 percent of Canada's Atlantic tidal and salt marshes, 70 percent of the lower Great Lakes-St. Lawrence River shoreline marshes and swamps, up to 71 percent of prairie potholes and sloughs, and 80 percent of Pacific coast estuarine wetlands are estimated to have been converted to other uses. Overall wetland losses exceeding 50 percent of original area have been reported by the Netherlands, Germany, Spain, Greece, Italy, France and parts of Portugal. In the United Kingdom, loss rates of 23 percent of estuaries and 50 percent of saltmarshes since Roman times, and 40 percent of wet grasslands have been reported. One study allowing broad comparisons for a particular wetland type across the whole of Europe reports loss rates for peatlands in excess of 50 percent for 11 European countries. A review of wetland inventories in Southern Africa gives some information on the extent of wetland resources in 10 countries in the region. Loss figures are given for two areas in Natal – the Tugela Basin, where over 90 percent of the wetland resources have been lost in parts of the basin; and the Mfolozi catchment (10,000 sq.km), where 58 percent of the original wetland area (502 sq.km) had been lost. The only other quantitative information arises from the wetland inventory of Tunisia, which reports an overall loss of 15 percent of wetland area, and 84 percent loss in the Medjerda catchment. In another review, it was reported an overall loss of 31 percent of wetlands in Indonesia, with loss of mangroves in Singapore, Philippines and Thailand being 97 percent, 78 percent, and 22 percent, respectively. In a review of peatland losses, loss rates were reported for Israel (100%), Thailand (82%), West Malaysia (71%), Indonesia (18%), China (13%), and Sarawak in East Malaysia (11%). For New Zealand, one estimate placed the loss rate at 90 percent of the original wetland area. For Australia, loss estimates were given for Victoria (27%), the southeastern part of South Australia (89%) and the Swan Plain Coast of South Australia in the recently published national wetland directory. The most detailed study for Victoria shows losses of fresh water marshes exceeding 70 percent, while there have been some gains through the creation of artificial wetlands such as sewage ponds and saltworks. [For reference information on this material see the Internet site

<http://www.npwrc.usgs.gov/resource/othrdata/wetloss/>

Wetland Losses, United States — The extent of wetland losses in the United States have been both widespread and severe. An analysis of losses between the 1780's and the 1980's indicates that a 53 percent loss occurred in the conterminous U.S. (i.e., excluding Alaska and Hawaii). The least impact has occurred in Alaska, where the state's massive 170 million acres of wetland resources have only suffered a 1 percent loss. Next lowest losses occurred for Hawaii (12%), New Hampshire (9%) and Rhode Island (37%). Ten states have lost over 70 percent of their wetlands, Ohio and California having lost most at 90 percent and 91 percent, respectively. Florida has lost approximately 9.3 million acres (46%). (See the accompanying table for a complete listing of estimates of wetland losses for all states.)

WETLAND LOSSES IN THE UNITED STATES — 1780's TO 1980's								
State	Surface Areas (Acres)			Estimated Wetland Areas – 1780's Compared to 1980's				
	Land	Water	Total	1780's	Percent Total	1980's	Percent Total	Percent Change
AL	32,544,640	485,120	33,029,760	7,567,600	22.9%	3,783,800	11.5%	-50%
AZ	72,680,320	221,440	72,901,760	931,000	1.3%	600,000	0.8%	-36%
AR	33,392,000	594,560	33,986,560	9,848,600	29.0%	2,763,600	8.1%	-72%
CA	100,183,680	1,379,840	101,563,520	5,000,000	4.9%	454,000	0.4%	-91%
CO	66,428,800	289,920	66,718,720	2,000,000	3.0%	1,000,000	1.5%	-50%
CT	3,116,800	88,960	3,205,760	670,000	20.9%	172,500	5.4%	-74%
DE	1,268,480	48,000	1,316,480	479,785	36.4%	223,000	16.9%	-54%
FL	34,647,040	2,831,360	37,478,400	20,325,013	54.2%	11,038,300	29.5%	-46%
GA	37,246,080	434,560	37,680,640	6,843,200	18.2%	5,298,200	14.1%	-23%
ID	52,906,880	563,200	53,470,080	877,000	1.6%	385,700	0.7%	-56%
IL	35,761,280	334,720	36,096,000	8,212,000	22.8%	1,254,500	3.5%	-85%
IN	23,160,960	65,280	23,226,240	5,600,000	24.1%	750,633	3.2%	-87%
IA	35,867,520	158,080	36,025,600	4,000,000	11.1%	421,900	1.2%	-89%
KS	52,515,840	133,120	52,648,960	841,000	1.6%	435,400	0.8%	-48%
KY	25,504,640	348,160	25,852,800	1,566,000	6.1%	300,000	1.2%	-81%
LA	28,899,200	2,155,520	31,054,720	16,194,500	52.1%	8,784,200	28.3%	-46%
ME	19,797,120	1,460,480	21,257,600	6,460,000	30.4%	5,199,200	24.5%	-20%
MD	6,330,240	439,040	6,769,280	1,650,000	24.4%	440,000	6.5%	-73%
MA	5,013,120	271,360	5,284,480	818,000	15.5%	588,486	11.1%	-28%
MI	36,363,520	894,720	37,258,240	11,200,000	30.1%	5,583,400	15.0%	-50%
MN	50,744,960	3,058,560	53,803,520	15,070,000	28.0%	8,700,000	16.2%	-42%
MS	30,309,120	229,120	30,538,240	9,872,000	32.3%	4,067,000	13.3%	-59%
MO	44,189,440	409,600	44,599,040	4,844,000	10.9%	643,000	1.4%	-87%
MT	93,185,920	982,400	94,168,320	1,147,000	1.2%	840,300	0.9%	-27%
NE	48,974,080	451,200	49,425,280	2,910,500	5.9%	1,905,500	3.9%	-35%
NV	70,328,960	416,640	70,745,600	487,350	0.7%	236,350	0.3%	-52%
NH	5,781,120	173,440	5,954,560	220,000	3.7%	200,000	3.4%	-9%
NJ	4,820,480	194,560	5,015,040	1,500,000	29.9%	915,960	18.3%	-39%
NM	77,724,800	141,440	77,866,240	720,000	0.9%	481,900	0.6%	-33%
NY	30,636,160	1,092,480	31,728,640	2,562,000	8.1%	1,025,000	3.2%	-60%
NC	31,283,200	2,371,840	33,655,040	11,089,500	33.0%	5,689,500	16.9%	-49%
ND	44,339,200	886,400	45,225,600	4,927,500	10.9%	2,490,000	5.5%	-49%
OH	26,251,520	130,560	26,382,080	5,000,000	19.0%	482,800	1.8%	-90%
OK	44,149,760	598,400	44,748,160	2,842,600	6.4%	949,700	2.1%	-67%
OR	61,573,760	494,080	62,067,840	2,262,000	3.6%	1,393,900	2.2%	-38%
PA	28,816,000	197,120	29,013,120	1,127,000	3.9%	499,014	1.7%	-56%
RI	671,360	105,600	776,960	102,690	13.2%	65,154	8.4%	-37%
SC	19,379,200	496,000	19,875,200	6,414,000	32.3%	4,659,000	23.4%	-27%
SD	48,611,840	698,240	49,310,080	2,735,100	5.5%	1,780,000	3.6%	-35%
TN	26,474,240	561,920	27,036,160	1,937,000	7.2%	787,000	2.9%	-59%
TX	168,300,800	2,796,160	171,096,960	15,999,700	9.4%	7,612,412	4.4%	-52%
UT	52,723,840	1,622,400	54,346,240	802,000	1.5%	558,000	1.0%	-30%
VT	5,935,360	214,400	6,149,760	341,000	5.5%	220,000	3.6%	-35%
VA	25,498,240	624,640	26,122,880	1,849,000	7.1%	1,074,613	4.1%	-42%

WETLAND LOSSES IN THE UNITED STATES — 1780's TO 1980's								
State	Surface Areas (Acres)			Estimated Wetland Areas – 1780's Compared to 1980's				
	Land	Water	Total	1780's	Percent Total	1980's	Percent Total	Percent Change
WA	42,664,320	978,560	43,642,880	1,350,000	3.1%	938,000	2.1%	-31%
WV	15,413,760	62,080	15,475,840	134,000	0.9%	102,000	0.7%	-24%
WI	34,856,960	1,081,600	35,938,560	9,800,000	27.3%	5,331,392	14.8%	-46%
WY	62,259,840	405,120	62,664,960	2,000,000	3.2%	1,250,000	2.0%	-38%
Sub-Total – Contiguous States								
	1,899,526,400	34,672,000	1,934,198,400	221,129,638	11.4%	104,374,314	5.4%	-53%
Alaska and Hawaii (Non-Contiguous States)								
AK	362,516,480	12,787,200	375,303,680	170,200,000	45.3%	170,000,000	45.3%	-0.1%
HI	4,112,000	3,200	4,115,200	58,800	1.4%	51,800	1.3%	-12%
Total – All States								
U.S.	2,266,154,880	47,462,400	2,313,617,280	391,388,438	16.9%	274,426,114	11.9%	-30%
Notes: Surface Area – There are some discrepancies between the total surface area of states. These differences are probably due to shifting river channels forming state borders. The area given is that presented by the U.S. Geological Survey, National Atlas of the United States, 1970. Distribution – Wetland distribution and changes vary dramatically within states depending on both geographical and/or land use patterns. Source: Dahl, Thomas E., "Wetlands Losses in the United States – 1780's to 1980's," U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., 1990, Jamestown, North Dakota: U.S. Geological Survey, Northern Prairie Wildlife Research Center.								

Wetland Mitigation — Mitigation, a term frequently used synonymously with *Wetland Restoration*, refers to the restoration, creation, or enhancement of wetlands to compensate for permitted wetland losses. Under *Section 404* of the *Clean Water Act (CWA)*, wetlands may legally be destroyed, but their loss must be compensated for by the restoration, creation, or enhancement of other wetlands. In theory, this strategy should result in “no net loss” of wetlands. Unlike *Wetland Banking* or *Wetland “Clumping” (Aggregation)*, wetland mitigation deals with those actions taken to avoid, minimize, or deter the need to adversely affect existing *Wetlands* and similar habitats. Wetland mitigation deals in three fundamental areas:

- [1] **Avoidance** – involving a comprehensive evaluation of practicable alternatives to the proposed actions to demonstrate that the least environmentally damaging practicable alternative that satisfies the project purpose has been selected;
- [2] **Minimization** – where some actions adversely affecting existing wetland areas are unavoidable, then steps must be taken to insure that such adverse effects are minimized to every extent possible; and
- [3] **Compensatory Mitigation** – in the case of extensive or substantive wetland impacts, then alternative actions must be taken in conjunction to the proposed project to insure that new areas are added to existing wetland inventory (banking) and/or that alternative and comparable wetland habitat is created (clumping and aggregation).

Wetland banking and clumping (aggregation) concepts are only involved in the compensatory mitigation stage, and possibly the minimization of impacts stage, when all other actions have failed to prevent substantive impacts on existing wetlands. Also see *Wetland Mitigation Bank*.

Wetland Mitigation Bank — An arrangement whereby private developers buy credits of an acre or so each for the right to drain and build on *Wetlands* on their own property. The practice is generally permitted under *Section 404* of the federal *Clean Water Act (CWA)*, which requires developers to provide an equal amount of *Constructed Wetlands* for each acre of wetland destroyed. As an additional requirement, the mitigating wetlands must be created on land that historically was a wetland at one time or another. Developers are also required to both restore and maintain the mitigating wetlands. In states without enabling legislation for such banks, jurisdiction falls under the authority of the *U.S. Army Corps of Engineers (COE)*. Also see *Wetland Banking*, *Wetland Clumping (Aggregation)*, and *Wetland Mitigation*.

Wetland Protection/Maintenance — The removal of a threat to a wetland area, or the prevention of the decline in wetland conditions, or preventing potentially harmful action in or near a wetland. This may include the purchase of land or easement, repairing water control structures or fences, or structural protection such as repairing a barrier island. This term also includes activities commonly associated with the term *Wetland Preservation*. Such activities do not result in a gain of wetland acre or an increase in wetland functions; it merely preserves the status quo.

Wetland Restoration — (1) (National Research Council) The return of an ecosystem or a wetland to a close approximation of its condition prior to disturbance. The term restoration means the reestablishment of pre-disturbance aquatic functions and related physical, chemical and biological characteristics. Restoration is a comprehensive, extensive, an holistic process not achieved through the isolated manipulation of individual elements. The holistic nature of restoration means that merely recreating a form without the functions, or the functions in an artificial configuration bearing little resemblance to a natural form, does not constitute restoration. The objective is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs. Quite often restoration requires one or more of the following processes: (a) reconstruction of antecedent physical conditions; (b) chemical adjustment of the soil and water; and (c) biological manipulation, including the

reintroduction of absent native flora and fauna species. (2) (U.S. Federal Agencies) The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into:

- [1] **Re-Establishment** – The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Re-establishment results in rebuilding a former wetland and results in a gain in wetland acres; and
- [2] **Rehabilitation** – The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions of degraded wetland. Rehabilitation results in a gain in wetland function, but does not result in a gain in wetland acres.

Wetland Wise Use Guidelines [Ramsar Convention on Wetlands] — The “Wise Use Guidelines” of the *Ramsar Convention on Wetlands* call upon “Contracting Parties” to:

- [1] Adopt national wetland policies, involving a review of their existing legislation and institutional arrangements to deal with wetland matters (either as separate policy instruments or as part of national environmental action plans, national biodiversity strategies, or other national strategic planning);
- [2] Develop programs of wetland inventory, monitoring, research, training, education and public awareness; and
- [3] Take action at wetland sites, involving the development of integrated management plans covering every aspect of the wetlands.

The Guidelines emphasize the benefits and values of wetlands for sediment and erosion control; flood control; maintenance of water quality and abatement of pollution; maintenance of surface and underground water supply; support for fisheries, grazing and agriculture; outdoor recreation and education for human society; and climatic stability.

Wetlander — A person who lives in proximity to *Wetlands* and whose culture is linked to them.

Wetlands — See *Wetland, Wetlands (General)*.

Wetlands [United States, 33 CFR 328.3(b)] — The term “wetlands” means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetlands [COE] — (Regulatory) The *U.S. Army Corps of Engineers (COE)* has adopted a regulatory definition for administering the Section 404 permit program of the *Clean Water Act (CWA)* as follows: [Wetlands are] those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetlands [EPA] — (Regulatory) For regulatory purposes by the *U.S. Environmental Protection Agency (EPA)* and under the *Clean Water Act (CWA)*, the term wetlands means “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.” [Extracted from the EPA Regulations listed at 40 CFR 230.3(t).]

Wetlands [NRCS] — (Technical) The (U.S. Department of Agriculture) *Natural Resources Conservation Service (NRCS)* (formerly the *Soil Conservation Service — SCS*) uses the following definition for identifying wetlands on agricultural land in assessing farmer eligibility for U.S. Department of Agriculture program benefits under the “Swampbuster” provision of the *Food Security Act (FSA)* of 1985. As amended in 1990, the FSA states that the term “wetland,” except when such term is part of the term “converted wetland,” means land that

- [1] has a predominance of hydric soils;
- [2] is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions; and
- [3] under normal circumstances does support a prevalence of such vegetation.

For purposes of the 1990 amended FSA, and any other act, this term shall not include lands in Alaska identified as having high potential for agricultural development which have a predominance of permafrost soils.

Wetlands [Ramsar Convention on Wetlands] — Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by shallow water. The *Ramsar Convention on Wetlands* takes a broad approach in determining the wetlands which come under its aegis. Under the text of the Convention (Article 1.1), wetlands are defined as “...areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.” In addition, the Convention (Article 2.1) provides that wetlands “...may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands.” As a result of these provisions, the coverage of the Convention extends to a wide variety of habitat types, including rivers and lakes, coastal lagoons, mangroves, peatlands, and even

coral reefs. In addition there are human-made wetlands such as fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans, reservoirs, gravel pits, sewage farms, and canals.

Wetlands [USFWS] — (Regulatory and Environmental) The *U.S. Fish and Wildlife Service (USFWS)* has defined wetlands as follows: Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes:

- [1] at least periodically, the land supports predominantly *Hydrophytes (Hydrophytic Vegetation)*;
- [2] the substrate is predominantly undrained *Hydric Soils*; and
- [3] the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (*Wetland Hydrology*).

The term wetland includes a variety of areas that fall into one of five categories:

- [1] areas with hydrophytes and hydric soils, such as those commonly known as marshes, swamps, and bogs;
- [2] areas without hydrophytes but with hydric soils – for example, flats where drastic fluctuation in water level, wave action, turbidity, or high concentration of salts may prevent the growth of hydrophytes;
- [3] areas with hydrophytes but nonhydric soils, such as margins of impoundments or excavations where hydrophytes have become established but hydric soils have not yet developed;
- [4] areas without soils but with hydrophytes such as the seaweed-covered portion of rocky shores; and
- [5] wetlands without soil and without hydrophytes, such as gravel beaches or rocky shores without vegetation.

While *Wetlands* and *Deepwater Habitats* are defined separately, the USFWS approach to a definition views these two regimes as a continuum of an ecological classification system, and therefore both must be considered in an ecological approach to classification. The deepwater habitat/wetland classification includes five major systems:

- [1] Marine
- [2] Estuarine
- [3] Riverine
- [4] Lacustrine
- [5] Palustrine

The first four of these classifications include both wetland and deepwater habitats, but only the Palustrine System [see *Wetlands, Palustrine*] includes only wetland habitats. Wetlands have been found to provide many valuable functions to include groundwater recharge and discharge, flood flow alteration, sediment stabilization, sediment and toxicant retention, nutrient removal and/or transformation, diverse wildlife and aquatic habitats, and recreation [see *Wetlands, Benefits*]. Also see *Deepwater Habitat*.

Wetlands [California] — Wetlands are transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is often covered by shallow water during some parts of the year. Wetlands can be categorized according to specific habitat and type of vegetation. In general, wetlands are divided into:

- [1] ***Saltwater and Brackish Water Marshes*** – Usually located in coastal areas;
- [2] ***Freshwater Wetlands*** – Located primarily in the inland areas of California; and
- [3] ***Freshwater Forested and Scrub Wetlands*** – Commonly referred to as riparian habitat and exist along streams and adjacent to lakes.

Wetlands [Nevada] — (State Wildlife Management Areas – WMAs) Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands typically include swamps, marshes, bogs, playas, springs, seeps, and similar areas. Wetlands are land transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water. For the purpose of this classification wetlands must have one or more of the following attributes:

- [1] ***Hydrophytic Vegetation*** – At least periodically, the land supports predominantly water-loving plants (hydrophytes), such as cattails, rushes, or sedges;
- [2] ***Hydric Soil*** – Contains undrained, wet soil which lacks oxygen in the upper region;
- [3] ***Wetland Hydrology*** – The substrate is periodically or permanently saturated with or covered by water at some point of time in the growing season during a 30-year mean hydrologic period.

Frequently in Nevada, wetlands within the state's *Wildlife Management Areas (WMAs)* are only wet during a portion of the year, and sometimes they are dry for more than a year at a time. Because of this, Nevada's regional differences in climate and hydrology must be considered for the purpose of wetland identification, inventory, and classification.

Wetlands, Adjacent [United States, 33 CFR 328.3(c)] — See *Adjacent Wetlands*.

Wetlands America Trust — See *Ducks Unlimited (DU)*.

Wetlands and Deepwater Habitats Classification System [USFWS] – The following represents wetland and deepwater habitat

classifications based on systems and subsystems based on the U.S. Fish and Wildlife Service, Office of Biological Services, as reprinted from *Classification of Wetlands and Deepwater Habitats of the United States*.

[1] **Marine System**

- **Definition** – The Marine System consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the water regimes are determined primarily by the ebb and flow of oceanic tides. Salinities exceed 30‰ (parts per thousand), with little or no dilution except outside the mouths of estuaries. Shallow coastal indentations or bays without appreciable freshwater inflow, and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves, are also considered part of the Marine System because they generally support typical marine biota.
- **Limits** – The Marine System extends from the outer edge of the continental shelf shoreward to one of three lines: (1) the landward limit of tidal inundation (extreme high water of spring tides), including the splash zone from breaking waves; (2) the seaward limit of wetland emergents, trees, or shrubs, or (3) the seaward limit of the Estuarine System, where this limit is determined by factors other than vegetation. Deepwater habitats lying beyond the seaward limit of the Marine System are outside the scope of this classification system.
- **Description** – The distribution of plants and animals in the Marine System primarily reflects differences in four factors: (1) degree of exposure of the site to waves; (2) texture and physicochemical nature of the substrate; (3) amplitude of the tides; and (4) latitude, which governs water temperature, the intensity and duration of solar radiation, and the presence or absence of ice.
- **Subsystems** – (1) Subtidal – The substrate is continuously submerged. (2) Intertidal – The substrate is exposed and flooded by tides; includes the associated splash zone.

[2] **Estuarine System**

- **Definition** – The Estuarine System consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semienclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The salinity may be periodically increased above that of the open ocean by evaporation. Along some low-energy coastlines there is appreciable dilution of sea water. Offshore areas with typical estuarine plants and animals, such as red mangroves (*Rhizophora mangle*) and eastern oysters (*Crassostrea virginica*), are also included in the Estuarine System.
- **Limits** – The Estuarine System extends (1) upstream and landward to where ocean-derived salts measure less than 0.5‰ during the period of average annual low flow; (2) to an imaginary line closing the mouth of a river, bay, or sound; and (3) to the seaward limit of wetland emergents, shrubs, or trees where they are not included in (2), above. The Estuarine System also includes offshore areas of continuously diluted sea water.
- **Description** – The Estuarine System includes both estuaries and lagoons. It is more strongly influenced by its association with land than is the Marine System. In terms of wave action, estuaries are generally considered to be low-energy systems. Estuarine water regimes and water chemistry are affected by one or more of the following forces: oceanic tides, precipitation, freshwater runoff from land areas, evaporation, and wind. Estuarine salinities range from hyperhaline to oligohaline. The salinity may be variable, as in hyperhaline lagoons (e.g., Laguna Madre, Texas) and most brackish estuaries (e.g., Chesapeake Bay, Virginia-Maryland); or it may be relatively stable, as in sheltered euhaline embayments (e.g., Chincoteague Bay, Maryland) or brackish embayments with partly obstructed access or small tidal range (e.g., Pamlico Sound, North Carolina).
- **Subsystems** – (1) Subtidal – The substrate is continuously submerged. (2) Intertidal – The substrate is exposed and flooded by tides; includes the associated splash zone.

[3] **Riverine System**

- **Definition** – The Riverine System includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5‰. A channel is “an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water.”
- **Limits** – The Riverine System is bounded on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. In braided streams, the system is bounded by the banks forming the outer limits of the depression within which the braiding occurs. The Riverine System terminates at the downstream end where the concentration of ocean-derived salts in the water exceeds 0.5‰ during the period of annual average low flow, or where the channel enters a lake. It terminates at the upstream end where tributary streams originate,

or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System.

- **Description** – Water is usually, but not always, flowing in the Riverine System. Upland islands or Palustrine wetlands may occur in the channel, but they are not included in the Riverine System. Palustrine Moss-Lichen Wetlands, Emergent Wetlands, Scrub-Shrub Wetlands, and Forested Wetlands may occur adjacent to the Riverine System, often on a floodplain.
- **Subsystems** – The Riverine System is divided into four Subsystems: the Tidal, the Lower Perennial, the Upper Perennial, and the Intermittent. Each is defined in terms of water permanence, gradient, water velocity, substrate, and the extent of floodplain development. The Subsystems have characteristic flora and fauna. All four Subsystems are not necessarily present in all rivers, and the order of occurrence may be other than that given here. (1) Tidal – The gradient is low and water velocity fluctuates under tidal influence. The streambed is mainly mud with occasional patches of sand. Oxygen deficits may sometimes occur and the fauna is similar to that in the Lower Perennial Subsystem. The floodplain is typically well developed. (2) Lower Perennial – The gradient is low and water velocity is slow. There is no tidal influence, and some water flows throughout the year. The substrate consist mainly of sand and mud. Oxygen deficits may sometimes occur, the fauna is composed mostly of species that reach their maximum abundance in still water, and true planktonic organisms are common. The gradient is lower than that of the Upper Perennial Subsystem and the floodplain is well developed. (3) Upper Perennial – The gradient is high and velocity of the water fast. There is not tidal influences and some water flows throughout the year. The substrate consists of rock, cobbles, or gravel with occasional patches of sand. The natural dissolved oxygen concentration is normally near saturation. The fauna is characteristic of running water, and there are few or no planktonic forms. The gradient is high compared with that of the Lower Perennial Subsystem, and there is very little floodplain development. (4) Intermittent – In this subsystem, the channel contains flowing water for only part of the year. When the water is not flowing, it may remain in isolated pools or surface water may be absent.

[4] **Lacustrine System**

- **Definition** – The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent areal coverage; and (3) total area exceeds 8 ha (20 acres). Similar wetland and deepwater habitats totaling less than 8 ha are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 2 m (6.6 feet) at low water. Lacustrine waters may be tidal or nontidal, but ocean-derived salinity is always less than 0.5‰.
- **Limits** – The Lacustrine System is bounded by upland or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Lacustrine Systems formed by damming a river channel are bounded by a contour approximating the normal spillway elevation or normal pool elevation, except where Palustrine wetlands extend lakeward of that boundary. Where a river enters a lake, the extension of the Lacustrine shoreline forms the Riverine–Lacustrine boundary.
- **Description** – The Lacustrine System includes permanently flooded lakes and reservoirs, intermittent lakes (e.g., playa lakes), and tidal lakes with ocean-derived salinities below 0.5‰. Typically, there are extensive areas of deep water and there is considerable wave action. Islands of Palustrine wetland may lie within the boundaries of the Lacustrine System.
- **Subsystems** – (1) Limnetic – All deepwater habitats within the Lacustrine Systems; many small Lacustrine Systems have no Limnetic Subsystems. (2) Littoral – All wetland habitats in the Lacustrine System. Extends from the shoreward boundary of the system to a depth of 2 m (6.6 feet) below low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 m.

[5] **Palustrine System**

- **Definition** – The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5‰. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2 m at low water; and (4) salinity due to ocean-derived salts less than 0.5‰.
- **Limits** – The Palustrine System is bounded by upland or by any of the other four Systems.
- **Description** – The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands

may be situated shoreward of lakes, river channels, or estuaries; or river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. The erosive forces of wind and water are of minor importance except during severe floods. There is often great similarities between wetlands lying adjacent to lakes or rivers and isolated wetlands of the same class in basins without open water.

- Subsystems – None.

Salinity Modifiers Used in the Wetland and Deepwater Habitat Classification System

Coastal Modifiers ¹	Inland Modifiers ²	Salinity (parts per thousand)	Approximate Specific Conductance (FMhos @25EC)
Hyperhaline	Hypersaline	>40	>60,000
Euhaline	Eusaline	30.0–40.0	45,000–60,000
Mixohaline (Brackish)	Mixosaline ³	0.5–30.0	800–45,000
Polyhaline	Polysaline	18.0–30.0	30,000–45,000
Mesohaline	Mesosaline	5.0–18.0	8,000–30,000
Oligohaline	Oligosaline	0.5–5.0	800–8,000
Fresh	Fresh	<0.5	<800

¹ Coastal Modifiers are used in the Marine and Estuarine Systems.

² Inland Modifiers are used in the Riverine, Lacustrine, and Palustrine Systems.

³ The term Brackish should not be used for inland wetlands or deepwater habitats.

Wetlands Assessment Model [Corps] — A relatively simple model used in the *U.S. Army Corps of Engineers' (Corps) Hydrogeomorphic Approach* to wetland assessment and classification that defines the relationship between ecosystem and landscape scale variables and functional capacity of a wetland. The model is developed and calibrated using *Reference Wetlands* from a reference domain. Also see *Wetland Functional Capacity Index*.

Wetlands Assessment Objective [Corps] — The rationale behind an assessment of wetland functions as conducted by the *U.S. Army Corps of Engineers' (Corps)* in its *Hydrogeomorphic Approach* to wetland assessment and classification. Assessment objectives normally fall into one of three categories. These include: (a) documenting existing wetland conditions; (b) comparing different wetlands at the same point in time (e.g., an alternatives analysis); and (c) comparing the same wetland at different points in time (e.g. impact analysis or mitigation success).

Wetlands, Benefits — Since colonial times, an estimated 54 percent of the total wetland areas in the United States have vanished. In a major study by the U.S. Department of the Interior, *U.S. Fish and Wildlife Service (USFWS)*, during the 20 years from the mid-1950's to the mid-1970's, such losses averaged 458,000 acres each year. More recent studies have clearly demonstrated that wetlands are precious ecological resources that nurture wildlife, purify polluted waters, check the destructive power of floods and storms, and provide a variety of recreational activities. The following constitutes a listing of some of the major benefits of these ecological systems:

- [1] **Waterfowl Breeding** – Over 12 million ducks nest and breed annually in northern U.S. wetlands. This area, when combined with similar habitats in the Canadian prairies, accounts for 60-70 percent of the continent's breeding duck population.
- [2] **Habitat for Waterfowl and Other Birds** – Some 2½ million of the 3 million mallards in the Mississippi Flyway and nearly 100 percent of our 4 million wood ducks spend the winter in flooded bottomland forests and marshlands throughout the south.
- [3] **Biological Diversity and Wildlife Habitat** – Wetlands provide food and shelter for a great variety of fur-bearing animals and other kinds of wildlife.
- [4] **Habitat for Threatened and Endangered Species** – At least one-third of the nation's threatened or endangered species live in wetland areas.
- [5] **Marine Fish and Shellfish Production** – Roughly two-thirds of our shellfish and important commercial and sport species of marine fish rely on coastal marshes for spawning and nursery grounds.
- [6] **Freshwater Fish** – Many of the 4½ million acres of open water areas found in our inland wetlands are ideal habitat for such sought-after species as bass, catfish, pike, bluegill, sunfish, and crappie.
- [7] **Timber Production** – Wetlands, especially bottomland forests, are rich sources of timber.
- [8] **Flood Control** – Wetlands temporarily store flood waters and thus reduce downstream losses of life and property.
- [9] **Water Quality** – Wetlands act as natural water purification mechanisms. They remove silt and filter out and absorb many pollutants such as waterborne chemicals and nutrients.
- [10] **Saltwater Intrusion Control** – The flow of freshwater through wetlands creates groundwater pressure that prevents

- saltwater from invading public water supplies.
- [11] **Shoreline Stabilization** – By absorbing wave and storm energy and slowing water currents, wetland vegetation serves as a buffer against shoreline erosion.
 - [12] **Reduction of Coastal Storm Damage** – Coastal marshes and mangrove stands help to blunt the force of major storms.
 - [13] **Recreational Opportunities** – Wetlands offer unspoiled, open space for the aesthetic enjoyment of nature as well as activities such as hiking, fishing, hunting, photography, and environmental education.
 - [14] **Groundwater Recharge and Discharge** – Water standing in or slowing moving through wetland areas provides important recharge opportunities to groundwaters while water taken from the ground, for example through mine *Dewatering* operations, is frequently released into wetland areas for further treatment of potentially harmful substances.
 - [15] **Sediment Stabilization** – Through their ability to slow the flow of water and the filtering capabilities of associated flora, wetlands provide important functions for the removal and trapping of sediment and other materials in water affecting its *Turbidity* and its levels of *Dissolved* and *Suspended Solids*.
 - [16] **Sediment and Toxicant Retention** – Wetland vegetation inherently provides important functions in the retention and absorption of various dissolved and suspended materials in the waters entering these areas as well as providing for the removal of various chemical and toxic substances as well as some heavy metals.
 - [17] **Nutrient Removal and/or Transformation** – Wetland vegetation readily absorbs for its own use various nitrate and phosphate-based nutrients in the water, thereby increasing *Dissolved Oxygen* levels and the quality of downstream waters.

Wetlands, Benefits and Values — The following listing of the benefits and values of wetlands was extracted from the Water Education Foundation's *California Wetlands, A Briefing*.

- [1] **Water Quality** – Water passing through wetlands contains organisms, sediments, nutrients, and pollutants that could degrade groundwater or the water quality of rivers, lakes, and estuaries. The vegetation and soil in the wetland filter the water and do such a remarkable job of absorbing nutrients and contaminants that they have been called the “kidneys of the landscape.” Some wetland plants, such as tules, reeds, and cattails, are remarkably effective biofilters, breaking down harmful pollutants into simple forms which not only can be used for food for other organisms, but also can make water easier to treat for urban uses. It has been estimated that one acre of wetlands can filter 7.3 million gallons of water a year.
- [2] **Flood Control** – Wetlands can reduce the effect of floods by temporarily storing flood waters and detaining the flow of water through the sponging effect of the soil and the barrier effect of the vegetation. After absorbing and detaining this water, wetlands slowly release it back into the stream system, both mitigating the effects of flood flows and prolonging the flows in more seasonal streams.
- [3] **Groundwater Recharge** – Some wetlands recharge underground aquifers that provide urban and agricultural water supplies. Their benefit to the aquifer is not only the filtering service they provide, but also their ability to absorb and hold floodwaters so that a larger amount of the precipitation is stored as groundwater and not lost as surface runoff or evaporation.
- [4] **Erosion Control** – Wetlands protect the bodies of water they border by stabilizing the banks of rivers and streams, reducing and slowing floodwaters, thereby reducing erosion. Wetlands also protect croplands from excessive storm and floodwater erosion.
- [5] **Shoreline Stabilization** – Coastal wetlands help prevent shoreline erosion by minimizing the effects of wave action, tidal fluctuations, and storm run-off. Erosion control and shoreline stabilization have an economic as well as aesthetic impact, saving local, regional, and state agencies from having to spend many millions of dollars in artificial protections and/or repair and reconstruction costs.
- [6] **Saltwater Intrusion Control** – The flow of freshwater through wetlands creates groundwater pressure that prevents sea water from invading public water supplies as well as freshwater habits upstream of estuaries.
- [7] **Fisheries and Shellfish** – Wetlands provide direct spawning and rearing habitats and food supply that support both freshwater and marine fisheries.
- [8] **Oxygen Production** – Wetlands rival rain forests and coral reefs in importance to the oxygen and carbon cycles. Some estimates have shown that a healthy salt marsh produces five to 10 times as much oxygen and corresponding carbohydrate biomass per acre as a wheat field. This biomass forms the basis of the wetland food web. It is consumed by hundreds of species, creating a vast food web for fish, birds, and humans.
- [9] **Wildlife Habitat** – Among the most biologically productive natural ecosystems in the world, wetlands are vital to the survival of as many as 43 percent of the nation's 900-plus threatened and endangered species.
- [10] **Waterfowl Habitat** – The combination of vegetation and open water in wetlands provides food, rearing areas, and cover for waterfowl and shorebirds. Wetlands affect international bird populations and provide critical wintering habitat for millions of birds traveling annually along established flyways.

- [11] **Recreation** – Wetlands support a multi-million dollar fishing, hunting, and outdoor recreation industry in the United States. The diversity of wildlife and aesthetic qualities found in many wetlands attract large numbers of outdoor enthusiasts, including hunters, anglers, boaters, birdwatchers, and photographers.

Wetlands, Coastal — See *Coastal Wetlands*.

Wetlands, Constructed — (1) Wetlands constructed by man either as part of a *Wetland Banking*, *Wetland Clumping (Aggregation)*, or *Wetland Mitigation* program, or to achieve some other environmental preservation or restoration program. (2) (Water Quality) Wetlands constructed specifically for the purpose of treating waste water effluent before re-entering a stream or other body of water or being allowed to percolate into the groundwater. Also see *Lagoon*.

Wetlands, Current Status — It is estimated that 220 million acres of wetlands existed in the coterminous United States (lower 48 states) in colonial times. Today, by comparison, less than half that amount remains (about 100 million acres). Roughly 5 percent of the lower 48 states contains wetlands. Alaska alone possesses over 200 million acres, more than twice the acreage of all other states combined. From the mid-1950's to the mid-1970's, the coterminous U.S. lost an average of 458,000 acres of wetland per year. Between the mid-1970's to the mid-1980's, the loss rate dropped to about 290,000 acres per year. Today, the annual loss rate is somewhere between 70,000 and 110,000 acres. The dramatic decline in wetland losses is attributed to wetland regulations (federal and state), improvements in land use policies (discourage wetland filling), and, more recently, government-sponsored wetland restoration projects. These restoration programs have aided in increasing wetland acreage by either bringing hydrology back to formerly drained wetlands or by improving the functions of previously altered wetlands. States with more than 20 percent of their land area represented by wetlands are:

- Alaska (48%)
- Louisiana (36%)
- Florida (33%)
- Maine (26%)
- Minnesota (21%)
- South Carolina (21%)

Those states with 10-20 percent of their land mass in wetlands are:

- New Jersey (19%)
- Delaware (18%)
- Georgia (18%)
- North Carolina (16%)
- Wisconsin (15%)
- Michigan (15%)
- Mississippi (14%)
- Massachusetts (12%)
- Arkansas (10%)

States with less than 1 percent of their territory occupied by wetlands are:

- Montana (0.9%)
- Arizona (0.8%)
- Kansas (0.8%)
- Idaho (0.7%)
- Nevada (0.6%)
- New Mexico (0.6%)
- California (0.5%)
- West Virginia (0.4%)

Although wetlands are receiving better protection today than in the past, wetland losses still continue. The largest losses in the U.S. are believed to be taking place in the Southeast (e.g., Florida, Georgia, South Carolina, North Carolina, Louisiana, Arkansas, and Mississippi). Most of these states are losing forested wetlands to agriculture; however, recent agricultural policies may be reducing this type of wetland conversion. By contrast, Louisiana is losing coastal wetlands to submergence, which is estimated at 50 square miles per year.

Wetlands, Definition [EPA Regulations, 40 CFR 230.3(t)] — Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Indeed, wetlands are found from the tundra to the tropics and on every continent except Antarctica. For regulatory purposes under the *Clean Water Act (CWA)*, the term wetlands means “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that

under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.”

Wetlands, Extent [Ramsar Convention on Wetlands] — Wetlands occur in every country, from the tundra to the tropics. While to total area of the earth’s surface that is presently composed of wetlands is not known exactly, the World Conservation Monitoring Centre has suggested an estimate of about 570 million hectares (1.408 billion acres, 2.201 million square miles, 5.700 million square kilometers), or approximately 6 percent of the earth’s land surface. Of this total, approximately 2 percent of the “wetlands” are contained in lakes, 30 percent as bogs, 26 percent as fens, 20 percent as swamps, and 15 percent as floodplains. Mangroves cover some 240,000 square kilometers (92,660 square miles) of coastal area, and an estimated 600,000 square kilometers (231,660 square miles) of coral reefs remain worldwide. Nevertheless, a global review of wetland resources submitted to the Conference of the Parties to the Convention on Wetlands in 1999, while affirming that “it is not possible to provide an acceptable figure of the areal extent of wetlands at a global scale,” indicated a ‘best’ minimum global estimate at between 748 and 778 million hectares. The same report indicated that this “minimum” could be increased to a total of between 999 and 4,462 million hectares when other sources of information were taken into account.

Wetlands Extent, Structure, and Hydrology (Geoindicator) [GCRIQ] — Wetlands are areas of high biological productivity and diversity. They provide important sites for wildlife habitat and human recreation. Wetlands mediate large and small-scale environmental processes by altering downstream catchments. The dissolved carbon burden of wetlands may affect downstream waters, for example, by acid drainage. Wetlands can affect local hydrology by acting as a filter, sequestering and storing heavy metals and other pollutants, such as mercury (Hg), and serving as flood buffers and, in coastal zones, as storm defenses and erosion controls. Wetlands are complex and sensitive ecosystems, characterized by a water table at or near the land surface for some part of the year, by soil conditions that differ from adjacent uplands, and by vegetation adapted to wet conditions. Wetlands are usually classified on the basis of their morphology and vegetation and, to a lesser extent, their hydrology. Though definitions vary, the following types are widely recognized:

- [1] Coastal salt and freshwater marshes;
- [2] Swamps (mangrove, shrub and wooded);
- [3] Wet grasslands;
- [4] Meadows and prairies; and
- [5] Peatlands (landforms in which organic sediments have accumulated to depths in excess of 30-50 centimeters, including mires, moors, muskeg, bogs and fens).

The areal extent, distribution, and surface and internal structures of a wetland can be altered by many processes, such as organic and inorganic sediment deposition and erosion, paludification (lateral spread), terrestrialization (colonization of open water by wetland plant communities), and changing hydrology. In the case of coastal wetlands, saltwater intrusion and changes in sea level can also be important. Hydrological relationships play a key role in wetland ecosystem processes, and in determining structure and growth. Different wetlands have a characteristic hydroperiod, or seasonal pattern of water levels, that defines the rise and fall of surface and subsurface water. An important *Geoindicator* is the water budget of a wetland, which links inputs from groundwater, runoff, precipitation, and physical forces (wind, tides) with outputs from drainage, recharge, evaporation and transpiration. Annual or seasonal changes in the range of water levels affect visible surface biota, decay processes, accumulation rates, and gas emissions. Such changes can occur in response to a range of external factors, such as fluctuations in water source (river diversions, groundwater pumping), climate or land use (forest clearing). Waters flowing out of wetlands are chemically distinct from inflow waters, because a range of physical and chemical reactions take place as water passes through organic materials, such as peat, causing some elements (e.g. heavy metals) to be sequestered and others (e.g. DOC, humic acids) to be mobilized.

Wetlands, Historical Definition (United States, 1890) — One of the earliest wetland definitions used in the United States may be found in an 1890 federal government report on wetlands titled “General Account of the Freshwater Morasses of the United States” (by Nathaniel Shaler). According to this document, “all wetlands...in which the natural declivity is insufficient, when the forest cover is removed, to reduce the soil to the measure of dryness necessary for agriculture...Wherever any form of engineering is necessary to secure this desiccation, the area is classified as swamp.” Consequently, early definitions of wetlands were strictly based on human activities and land usage, i.e., wetlands were recognized as areas that were either too wet to farm or too wet to build upon without draining or filling.

Wetlands, Inland — See *Inland Wetlands*.

Wetlands International -- Wetlands International is the leading global non-profit organization dedicated solely to the crucial work of wetland conservation and sustainable management. Well-established networks of expert and close partnerships with key organizations, particularly the Ramsar Institute (*Ramsar Convention on Wetlands*), provide Wetlands International with the essential tools for catalyzing conservation activities worldwide. Organizational activities are based on sound science and carried out in over 120 countries around the world. The mission of Wetlands International is to sustain and restore wetlands, their resources and biodiversity for future generations through research, information exchange and conservation activities, worldwide. Wetlands International and its precursors have long been actively involved in organizing and supporting wetland inventory projects from around the globe. A few of the many examples include compilation of directories of “important” wetlands in Asia,

the Middle East, the Neotropics and Oceania, as well as Ramsar Site directories. Most such regional inventories have been concerned with wetlands considered to be important according to either national or international criteria. In this regard, there have generally not been comprehensive wetland inventories as such. However, as water quality issues come to the forefront, there has been growing interest and concern about the world's wetland resources and more precisely a determination of the extent of wetlands areas throughout the world. Wetlands International has been working in cooperation with the Ramsar Convention Bureau to better assess both the extent and changes in the amount of wetland resources. An ongoing wetland inventory project by Wetlands International and other international agencies is seeking to improve knowledge on the status and distribution of wetlands in Europe.

Wetlands Inventory — See *National Wetlands Inventory (NWI)* [USFWS].

Wetlands, Jurisdictional [Corps] — An area that meets the criteria established by the *U.S. Army Corps of Engineers (Corps or COE)* for a *Wetlands* (as set forth in their *Wetlands Delineation Manual*). Such areas come under the jurisdiction of the Corps of Engineers for permitting certain actions such as dredge and fill operations. See *Wetlands*.

Wetlands Management — The maintenance or modification of *Wetlands* to achieve desired functions.

Wetlands of International Importance (United States) [Ramsar Convention on Wetlands] — At the time of joining the *Ramsar Convention on Wetlands*, each "Contracting Party" undertakes to designate at least one site for inclusion in the List of Wetlands of International Importance (the "Ramsar List"). The inclusion of a site in the Ramsar List confers upon it the prestige of international recognition and obliges the government to take all steps necessary to ensure the maintenance of the ecological character of the site. While inscription on the Ramsar List acknowledges the international importance of the site, Article 2.4 of the Convention established that "The inclusion of a wetland in the List does not prejudice the exclusive sovereign rights of the Contracting Party in whose territory the wetland is situated." Requirements of the Convention for designating Wetlands of International Importance for the United States took effect on April 18, 1987. The U.S. presently has 17 sites designated as Wetlands of International Importance, with a combined surface area of 1,177,980 hectares (2,910,840 acres, 4,550 square miles, 11,780 square kilometers). These sites are listed below, alphabetically, by site name; date of designation; state; surface area (hectares, acres, square miles, and square kilometers); coordinates (latitude and longitude); other designations; and a brief description of the wetland site and features.

- [1] **Ash Meadows National Wildlife Refuge** – December 18, 1986; Nevada; 9,509 hectares (23,497 acres, 36.7 square miles, 95.1 square kilometers); 36E25' N 116E20' W. National Wildlife Refuge. A unique oasis ecosystem of streams, pools, and wet meadows, formed around springs supplying a tributary of the Amargosa River. The site lies within an area exhibiting the greatest biological endemism in the United States. Four species of endangered endemic fish and an endemic aquatic insect are present, and several of the region's plants are listed as threatened or endangered endemic species. Other endemics include several mollusks and one mammal. The water table is close to the surface and soils are mostly saline, often with a well-developed salt crust. Human activities have consisted of agriculture, irrigation, peat and clay mining, and off-road vehicle use. Ramsar site 347.
- [2] **Bolinas Lagoon** – September 1, 1998; California; 445 hectares (1100 acres, 1.7 square miles, 4.4 square kilometers); 37E55' N 122E41' W. Located in California, less than 20 kilometers (12.4 miles) up the coast from San Francisco's Golden Gate Bridge, Bolinas Lagoon is a tidal embayment of open water, mudflat, and marsh which provides productive and diverse habitats for marine fishes, waterbirds, and marine mammals, and it is also part of a much larger protected natural habitat complex in the region. The site is located on the Pacific Flyway, which makes the Lagoon an ideal staging ground and stopover site for migratory birds, and the temperate climate provides wintering habitat for a wide array of ducks, geese, and shorebirds. The area supports a number of recreational uses, including the use of manually-powered watercraft. Ramsar site 960.
- [3] **Cache-Lower White Rivers** – November 21, 1989; Arkansas; 81,376 hectares (201,084 acres, 314.2 square miles, 813.8 square kilometers); 34E40' N 091E11' W. National Wildlife Refuge, Wildlife Management Area, Protected Areas. Half of the site is subject to late winter or spring flooding and permanent water consists of rivers, oxbow lakes, and swamps. Particularly notable for containing the longest continuous expanse of bottomland hardwoods (forested, periodically flooded wetlands) in the Lower Mississippi Valley, with the principal tree species varying according to frequency and duration of inundation. The area is internationally important for numerous species of wintering waterbirds, including up to 10,000 *Branta canadensis* and up to 100 individuals of the endangered eagle *Haliaeetus leucocephalus*. The site supports numerous species of game and fur-bearing mammals including the endangered bear *Ursus americanus*. The area is also important for conservation education, outdoor recreation, and scientific research. Ramsar site 442.
- [4] **Cache River – Cypress Creek Wetlands** – November 1, 1994; Illinois; 24,281 hectares (60,000 acres, 93.8 square miles, 242.8 square kilometers); 37E13' N 089E08' W. National Wildlife Refuge, National Natural Landmark, State Wildlife Management Area, State Natural Area. The confluence of four physiographic provinces with high biological diversity, high quality occurrences of rare communities and species, bottomland hardwoods, migratory waterbirds and bird habitat, ancient trees, and mammalian predators – a site with nationally and internationally significant and unique ecological values. Wetland types include swamps, shrub swamps, open water, wet floodplain

forests or bottomland hardwood forests, and wet farmland. Located on the Mississippi flyway, the area is important to migrating, staging and wintering waterfowl, especially ducks and geese. Since 1900, the basin has undergone substantial hydrological modifications. Restoration of the hydrologic system is a major management objective. Ramsar site 711.

- [5] **Caddo Lake** – October 23, 1993; Texas; 8,382 hectares (20,712 acres, 32.4 square miles, 83.8 square kilometers); 32E45' N 094E08' W. State Park, Wildlife Management Area. Shallow, heavily vegetated waters of the lake, its sloughs, swamps, backwaters, and hardwood forests. It is one of the best examples in the southern United States of the mature *Taxodium distichum* community. Wintering habitat is available for substantial numbers of waterbirds and one of the highest populations and best breeding area for *Aix sponsa* exists here. The mature hardwoods are vital to the survival and productivity of Neotropical migrants. There is small boat traffic to lakeside developments scattered throughout the site. The Caddo Lake Institute has been very active in pursuing Ramsar issues globally. Management of the site has benefited from Caddo Lake's association with Mr. Don Henley, a prominent musician and member of the Eagles rock group. Ramsar site 633.
- [6] **Catahoula Lake** – June 18, 1991; Louisiana; 12,150 hectares (30,023 acres, 46.9 square miles, 121.5 square kilometers); 31E30' N 092E06' W. National Wildlife Refuge. A large, poorly drained depression subject to artificially controlled, seasonal fluctuations. The lake is fed by the Little River and numerous smaller water courses and is subject to back-flooding. Few plants are ecologically adapted to the extreme variations in water level, although annual grasses and sedges flourish. The most important inland wetland for waterbirds in Louisiana, with peak counts exceeding 400,000 birds. The endangered eagle *Haliaeetus leucocephalus* occurs as a non-breeding visitor. The lake also supports sport and commercial fisheries. Long-term historical hunting at the site has led to a high density of lead pellets in the lake, the use of which is now illegal. The lake overlies an important oil field that has been commercially exploited for 40 years. Ramsar site 523.
- [7] **Chesapeake Bay Estuarine Complex** – June 4, 1987; Virginia; 45,000 hectares (111,197 acres, 173.8 square miles, 450 square kilometers); 38E00' N 076E20' W. National Wildlife Refuge, Wildlife Management Area, State Park, Natural Environment Area, Natural Resources Management Area. A vast estuarine complex, composed of multiple, physically separate protected areas. Ten major rivers enter the system. Natural habitats include sand beaches, dunes, mudflats, open water with submerged beds of aquatic vegetation, intertidal marshes, freshwater marshes, and lakes. The Bay is of particular importance for very large numbers of staging and wintering Anatidae (ducks, geese, swans, etc.) and other waterbirds. Breeding birds include two nationally endangered species. Other notable fauna include endangered marine turtles. The Bay's fishery (blue crab and oyster) is of significant economic importance, yielding a dockside value of \$60 million per year. Environmental education, conservation-oriented recreation, and scientific research are the primary management objectives. Hunting and trapping of birds and mammals are strictly controlled. Ramsar site 375.
- [8] **Cheyenne Bottoms State Game Area** – October 19, 1988; Kansas; 8,036 hectares (19,857 acres, 31 square miles, 80.4 square kilometers); 38E29' N 098E40' W. Western Hemisphere Shorebird Reserve, State Wildlife Area. A natural, elliptical basin on the Great Plains. Principle natural inflows to the basin are intermittent; additional water is supplied via an artificial canal. Several broad ecological zones are recognized, based on the vegetation communities present. Approximately 45 percent of all migratory shorebirds nesting in North America stage at Cheyenne Bottoms. Classified as "critical habitat" for the endangered crane *Grus americana*, the site supports other threatened or endangered birds during nesting, staging or wintering periods. Open to the public, it is an important area for conservation education, recreation and scientific research. Plans for industrial hog farming nearby remain an issue. Ramsar site 411.
- [9] **Connecticut River Estuary and Tidal Wetlands Complex** – October 14, 1994; Connecticut; 6,484 hectares (16,022 acres, 25 square miles, 64.8 square kilometers); 41E15' N 072E18' W. State Wildlife Management Areas, State Parks. The longest and largest river system in New England. Shifting sandbars have preserved the river's extraordinary assemblage of natural and undisturbed plant and animal communities. The site includes open water; fresh, salt and brackish tidal wetlands; floodplains, river islands, beaches, and dunes. The system serves as essential habitat for numerous regionally, nationally, and globally rare or otherwise significant species and forms an extensive biological corridor that links marine and estuarine waters of the Atlantic Ocean. Many migratory and Neotropical bird species nest or winter in the marshes, which regularly support over 10,000 individuals, consisting of 18 species of waterfowl. Two million people live in the river basin that supports active commercial and recreational fisheries, various tourist facilities and activities. Hunting and trapping represent considerable revenues to the state. Ramsar site 710.
- [10] **Delaware Bay Estuary** – May 20, 1992; Delaware, New Jersey; 51,252 hectares (126,646 acres, 198 square miles, 512.5 square kilometers); 39E11' N 075E14' W. Western Hemisphere Shorebird Reserve, National Wildlife Refuge, Wildlife Management Area, Fish & Wildlife Management Area, Nature Preserve, State Park. Major estuarine system in an ecological transition zone. The site consists of more than 70 separate protected wetland areas of varying

- salinity supporting various marsh communities. An important staging area for over 90 percent of the North American populations of several migratory shorebird species. More than one million individuals use the region, making it one of the two most important staging areas on the Atlantic coast of North America. Notable flora and fauna include five species of marine turtles, the endangered eagle *Haliaeetus leucocephalus*, and several rare or endangered plants. The crab fishery and hunting is valued at over \$85.5 million per year. Ramsar site 559.
- [11] **Edwin B. Forsythe National Wildlife Refuge** – December 18, 1986; New Jersey; 13,080 hectares (32,321 acres, 50.5 square miles, 130.8 square kilometers); 39E36' N 074E17' W. National Wildlife Refuge, Wilderness Area. Composed of two physically separate areas of the coastal plain, the site consists of beaches, saltmarshes, and meadows subject to tidal inundation, dry woodland, and wooded bottomland swamp. Rich in invertebrates, including commercially exploited shellfish, the saltmarshes and mudflats are important for various species of wintering *Anatidae* (ducks, geese, swans, etc.). Other fauna include 38 mammal species, several amphibians, and 11 reptiles. Hunting and trapping are strictly controlled. About 650 hectares of saltmarsh have been altered to collect freshwater runoff. Ramsar site 348.
- [12] **Everglades National Park** – June 4, 1987; Florida; 566,143 hectares (1,398,964 acres, 2,186 square miles, 5,661 square kilometers); 25E00' N 080E55' W. Added to the Montreux Record, 16 June 1993. World Heritage Site, Biosphere Reserve; National Park, Wilderness Area. A vast, shallow drainage basin consisting of two very broad zones. The first consists of large areas of freshwater and wet prairies, characterized by islands of tropical hardwood trees. The second is dominated by saltmarshes, mangrove forests, beach and dune complexes, and brackish water estuaries. This area is extremely important for nesting, staging and wintering birds, and supports a rich flora and several threatened and endangered species of flora and fauna. Over one thousand species of seed-bearing plants and 120 both tropical and temperate trees (60 of which are endemic) occur. The Everglades play an extremely important role in domestic, industrial and agricultural water supply, flood protection, and fishery support and is of prime importance in North America for conservation education and outdoor recreation. After years of give and take with sugar growers, serious efforts are being made to restore the natural water flow. Ramsar site 374.
- [13] **Horicon Marsh** – December 4, 1990; Wisconsin; 12,912 hectares (31,906 acres, 50 square miles, 129 square kilometers); 43E30' N 088E38' W. National Wildlife Refuge, State Wildlife Area, State Natural Area. One of the largest freshwater wetlands in the United States, with the geography forming a natural flyway for migratory waterbirds. Based on the vegetation, three broad ecological zones can be identified, consisting of marsh and peat areas, dotted with small pothole wetlands, and, during wet years, shallow lakes. The site supports an important mixed nesting colony of *Phalacrocoracidae* and *Ardeidae*. The marsh is an internationally important spring and fall staging area for more than 80 percent of the Mississippi flyway population of *Branta canadensis* (1.1 million birds) and 700,000 other geese during the fall migration. Surrounding areas are farmed intensively. Ramsar site 511.
- [14] **Izembek Lagoon National Wildlife Refuge** – December 18, 1986; Alaska; 168,433 hectares (416,205 acres, 650 square miles, 1,684 square kilometers); 55E45' N 162E41' W. National Wildlife Refuge, Wilderness Area. 39,000 hectares of intertidal wetlands, with extensive coastal lagoons, wet meadows, marshes separated from the Bering Sea by barrier islands and spits, including a tundra plain with scattered freshwater lakes and ponds. The landward part, strongly influenced by glaciation and vulcanism, is covered by glacial till. Critically important for migratory waterbirds, notably as spring and autumn staging sites for almost the entire world population of the goose *Branta bernicla nigricans*. Other staging birds include thousands of other geese and 300,000 ducks. Nesting species include *Cygnus columbianus columbianus*, while moderate to large numbers of other *Anatidae* (ducks, geese, swans, etc.) occur in winter. The site is also important for marine mammals and fish. Nearby there are substantial offshore petroleum operations. Ramsar site 349.
- [15] **Okefenokee National Wildlife Refuge** – December 18, 1986; Georgia, Florida; 159,889 hectares (395,093 acres, 617 square miles, 1,600 square kilometers); 30E49' N 082E20' W. National Wildlife Refuge, Wilderness Area. The site, the second largest wetland complex in the United States, is an extensive drainage basin on the divide between the Atlantic Ocean and Gulf of Mexico, characterized by swamp forest. Okefenokee supports one of the largest populations of *Alligator mississippiensis* in the United States and a wide diversity of breeding and non-breeding birds. Nesting birds include a rare woodpecker, while mammals include *Euarctos americanus* and *Odocoileus virginianus*. Human activities include nature conservation, hunting, fishing, and general recreation. Issues involving nearby titanium mining seem to be reaching a solution. Ramsar site 350.
- [16] **Pelican Island National Wildlife Refuge** – March 14, 1993; Florida; 1,908 hectares (4,715 acres, 7.4 square miles, 19.1 square kilometers); 27E48' N 080E25' W. National Wildlife Refuge, National Historic Landmark, Wilderness Area. A brackish estuarine area of three major habitat types. The site and its associated wetlands lie in a climatic zone of overlap between temperate and tropical, thus supporting plants and animals many of them threatened or endangered from both zones. Due to the mix of salt and fresh water, and the productivity of the lagoon system, a high degree of biological diversity is present at both species and community levels. The refuge and adjacent waters support thousands of migratory birds in winter as well as numerous nesting species and shorebirds. Management

goals include maintenance of quality habitat for endangered species, protection of nesting and feeding habitat for migratory birds, and promoting public awareness. Shellfish harvesting is a popular activity outside the designated area. Ramsar site 590.

- [17] **Sand Lake National Wildlife Refuge** – August 3, 1998; South Dakota; 8,700 hectares (21,498 acres, 33.6 square miles, 87 square kilometers); 45E45' N 098E15' W. A large freshwater cattail marsh, it provides critical nesting and staging habitat for many different bird species. The number of migrating waterfowl using the large wetland complex often exceeds 20,000 and includes such birds as Mallards, Wood ducks, and Canada geese. Sand Lake is also important habitat for reptiles, amphibians, fish, and mammals. Thousands of people from birdwatchers to anglers and hunters to hikers to school groups visit Sand Lake Refuge each year. Ramsar site 957.

Wetlands, Palustrine — Wetlands dominated by plants that persist throughout the year or the growing season. These areas are what most people think of when they see the term “wetland”, and include marshes, swamps, bogs, and wet meadows. Palustrine wetlands may be dominated by subtidal, permanently and intermittently flood areas (*Rock Bottom*, *Unconsolidated Bottom*, *Aquatic Bed*, and *Unconsolidated Shore*), mosses and lichens (*Moss-Lichen Wetlands*), erect, rooted, herbaceous hydrophytes such as sedges, rushes, grasses, cattails, and bulrushes (*Emergent Wetlands*), woody vegetation less than 6 meters (20 feet) tall (*Scrub-Shrub Wetlands*), or woody vegetation that is 6 meters (20 feet) or taller (*Forested Wetlands*). Palustrine wetlands may occur in the vicinity of springs, seeps, and flowing wells, on the floodplains of streams and creeks, around the shores of some lakes and reservoirs, adjacent to irrigation canals, and in areas influenced by irrigation or irrigation runoff. The following presents a more detailed description of these wetland classes:

- [1] **Rock Bottom** – The Class Rock Bottom includes all wetlands and deepwater habitats with substrates having an areal cover of stones, boulders, or bedrock 75 percent or greater and vegetative cover of less than 30 percent. Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semipermanently flooded. The rock substrate of the rocky benthic or bottom zone is one of the most important factors in determining the abundance, variety, and distribution of organisms. The stability of the bottom allows a rich assemblage of plants and animals to develop. Rock bottoms are usually high-energy habitats with well-aerated waters.
- [2] **Unconsolidated Bottom** – The Class Unconsolidated Bottom includes all wetland and deepwater habitats with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent. Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semipermanently flooded. Unconsolidated bottoms are characterized by the lack of large stable surfaces for plant and animal attachment. They are usually found in areas with lower energy than rock bottoms, and may be very unstable.
- [3] **Aquatic Bed** – The Class Aquatic Bed includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Water regimes include subtidal, irregularly exposed, regularly flooded, permanently flooded, intermittently exposed, semipermanently flooded, and seasonally flooded. Aquatic beds represent a diverse group of plant communities that requires surface water for optimum growth and reproduction. They are best developed in relatively permanent water or under conditions of repeated flooding.
- [4] **Unconsolidated Shore** – The Class Unconsolidated Shore includes all wetland habitats having three characteristics: (1) unconsolidated substrates with less than 75 percent areal cover of stones, boulders, or bedrock; (2) less than 30 percent areal cover of vegetation other than pioneering plants; and (3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded. Unconsolidated shores are characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms such as beaches, bars, and flats, all of which are included in this wetland class.
- [5] **Moss-Lichen Wetlands** – The Moss-Lichen Wetland Class includes areas where mosses or lichens cover substrates other than rock and where emergents, shrubs, or trees make up less than 30 percent of the areal cover. The only water regime is saturated. Mosses and lichens are important components of the flora in many wetlands, especially in the north, but these plants usually form a ground cover under a dominant layer of trees, shrubs, or emergents. In some instances higher order plants are uncommon and mosses or lichens dominate the flora. Such Moss-Lichen Wetlands are not common, even in the northern United States where they occur most frequently.
- [6] **Emergent Wetlands** – The Emergent Wetland Class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except sub-tidal and irregularly exposed. In areas with relatively stable climatic conditions, Emergent Wetlands maintain the same appearance year after year. In other areas, such as the prairies of the central United States, violent climatic fluctuations cause them to revert to an open water phase in some years. Emergent Wetlands are found throughout the United States and occur in all Wetland Classification Systems except the Marine. Emergent Wetlands are known by many names, including marsh, meadow, fen, prairie pothole, slough, and savanna.

- [7] **Scrub-Shrub Wetlands** – The Class Scrub-Shrub Wetland includes areas dominated by woody vegetation less than 6 meters (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except sub-tidal are included. Scrub-Shrub Wetlands may represent a successional stage leading to Forested Wetland, or they may be relatively stable communities. They occur only in the Estuarine and Palustrine Wetland Systems, but are one of the most widespread classes in the United States. Scrub-Shrub Wetlands are known by many names, such as shrub swamp, shrub carr, and pocosin (dismal).
- [8] **Forested Wetlands** – The Class Forested Wetland is characterized by woody vegetation that is 6 meters (20 feet) tall or taller. All water regimes are included except sub-tidal. Forested Wetlands are most common in the eastern United States and in those sections of the West where moisture is relatively abundant, particularly along rivers and in the mountains. They occur only in the Palustrine and Estuarine Wetland Systems and normally possess an overstory of trees, an understory of young trees or shrubs, and a herbaceous layer. Forested Wetlands in the Estuarine System, which include the mangrove forests of Florida, Puerto Rico, and the Virgin Islands, are known by such names as swamps, hammocks, heads, and bottoms. These names often occur in combination with species names or plant associations such as cedar swamp or bottomland hardwoods.

Wetlands, Productivity [Ramsar Convention on Wetlands] — Wetlands are among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. According to information compiled by the *Ramsar Convention on Wetlands*, of the 20,000 species of fish in the world, more than 40 percent live in fresh water. Wetlands are also important storehouses of plant genetic material. Rice, for example, which is a common wetland plant, is the staple diet of more than half of humanity. The interactions of physical, biological and chemical components of a wetland, such as soils, water, plants and animals, enable the wetland to perform many vital functions, for example: water storage; storm protection and flood mitigation; shoreline stabilization and erosion control; groundwater recharge (the movement of water from the wetland down into the underground aquifer); groundwater discharge (the movement of water upward to become surface water in a wetland); water purification through retention of nutrients, sediments, and pollutants; and stabilization of local climate conditions, particularly rainfall and temperature. Despite the uncertainties associated with the valuation of ecosystem services, some recent studies have indicated that ecosystems provide at least \$33 trillion (U.S.) worth of services annually, of which \$4.9 trillion (U.S.) are attributed to wetlands.

Wetlands Program [OWOW/EPA] — The *Office of Wetlands, Oceans, and Watersheds (OWOW)*, U.S. Environmental Protection Agency (EPA), promotes a watershed approach to manage, protect, and restore the water resources and aquatic ecosystems of our marine and fresh waters. The enduring mission of the Wetlands Program is to encourage and enable others to act effectively in protecting and restoring the nation's wetlands and associated ecosystems, including shallow open waters and free-flowing streams. In doing so, the program engages in two principal categories of activities – establishing national standards and assisting others to meet them. EPA serves specifically:

- [1] as a partner, providing support for both regulatory and non-regulatory wetlands protection efforts;
- [2] as a promoter and distributor of sound wetlands science as the technical basis for effective wetlands decision making;
- [3] in an advisory capacity for state and Tribal wetlands programs and for Clean Water Act Section 404 permit decisions;
- [4] as the developer of national wetlands standards and policies; and
- [5] as a regulator to back up its state and local partners and ensure that national standards are lawfully applied.

Legislative and other authorities for the OWOW's Wetland Programs include:

- Clean Water Act (CWA);
- Ocean Dumping Ban Act (ODBA);
- Coastal Zone Act Reauthorization Amendments (CZARA);
- London Convention (LC);
- Marine Plastics Pollution Research and Control Act (MPPRCA);
- Shore Protection Act (SPA);
- Marine Protection, Research, and Sanctuaries Act (MPRSA);
- Act to Prevent Pollution from Ships (APPS);
- International Convention for the Prevention of Pollution from Ships (MARPOL); and
- Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA).

Wetlands Research Center — See *National Wetlands Research Center (NWRC) [USGS]*.

Wetlands Research Program (WRP) [Corps] — The Wetlands Research Program was a four-year program designed to advance the state of the art of wetlands science, engineering, and technology. Major research areas included:

- [1] Critical Processes – Research addressed hydraulics, hydrology, sedimentation, erosion, water quality, and soils processes that affect wetlands;
- [2] Delineation and Evaluation of Wetlands – Methods to define the boundaries of wetlands by soil characteristics, hydrology, and vegetation, and to assess the ecological value of wetlands, were studied and examined;

- [3] Restoration and Establishment of Wetlands – Techniques for ensuring the success of restored and newly developed wetlands were surveyed and evaluated; and
- [4] Stewardship and Management of Wetlands – Better ways to inventory and manage Corps-owned wetlands were developed.

Also included in the Corps' Wetlands Research Program were studies assessing wetland changes and the cumulative impacts associated with these changes.

Wetlands Reserve Program (WRP) [NRCS] — The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The *Natural Resources Conservation Service (NRCS)*, U.S. Department of Agriculture (USDA), provides technical and financial support to help landowners with their wetland restoration efforts. The goal of the NRCS is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection beyond that which can be obtained through any other USDA program. The WRP was authorized by Congress under the Food Security Act of 1985, as amended by the 1990 and 1996 Farm Bills. The NRCS administers the program in consultation with the Farm Service Agency (FSA) and other federal agencies. Funding for WRP comes from the Commodity Credit Corporation (CCC). States were authorized to begin a continuous sign-up as of October 1, 1996. Landowners who choose to participate in WRP may sell a conservation easement or enter into a cost-share restoration agreement with USDA to restore and protect wetlands. The landowner voluntarily limits future use of the land, yet retains private ownership. The landowner and NRCS develop a plan for the restoration and maintenance of the wetland. The program offers landowners three options:

- [1] **Permanent Easement** – This is a conservation easement in perpetuity. Easement payment will be the lesser of: (a) the agricultural value of the land, (b) an established payment cap, or (c) an amount offered by the landowner. In addition to paying for the easement, USDA pays 100 percent of the costs of restoring the wetland;
- [2] **30-Year Easement** – This is a conservation easement lasting 30 years. Easement payments are 75 percent of what would be paid for a permanent easement. USDA also pays 75 percent of restoration costs; and
- [3] **Restoration Cost-Share Agreement** – This is an agreement (generally for a minimum of 10 years in duration) to re-establish degraded or lost wetland habitat. USDA pays 75 percent of the cost of the restoration activity. This does not place an easement on the property. The landowner provides the restoration site without reimbursement.

To be eligible for WRP, land must be restorable and be suitable for wildlife benefits. This includes, for example:

- Wetlands farmed under natural conditions;
- Farmed wetlands;
- Prior converted cropland;
- Farmed wetland pasture;
- Farmland that has become a wetland as a result of flooding;
- Rangeland, pasture, or production forestland where the hydrology has been significantly degraded and can be restored;
- Riparian areas which link protected wetlands;
- Lands adjacent to protected wetlands that contribute significantly to wetland functions and values; and
- Previously restored wetlands (Conservation Reserve Program [CRP] land is eligible if it meets WRP requirements).

Some examples of the success of the NRCS Wetlands Reserve Program:

- [1] Arkansas currently has 67,165 active acres of WRP lands and a backlog of more than 32,000 acres on unfunded registers.
- [2] California's present acreage enrollment, including offers made for 1999, is 47,149 acres with an unfunded backlog of 25,834 acres of perpetual easement applications and 10,984 acres of 30-year easement applications.
- [3] Indiana has 25,000 acres enrolled in WRP and currently a backlog of 69 applications on 4,500 acres.
- [4] As of December 13, 2000, NRCS total wetland projects in some stage of restoration in Iowa numbered 909, covering 102,707 acres. Of those restored wetlands projects, 423 are WRP projects, covering 45,886 acres.
- [5] Louisiana currently has recorded WRP easements on about 130,365 acres.
- [6] Currently, Michigan has over 125 easements and over 16,000 acres enrolled in WRP.
- [7] Since the 1992 WRP Pilot Program, there have been 249 easements enrolled in the state of Mississippi, encompassing 100,000 acres. This gives Mississippi the second largest enrollment of WRP acres in the nation. The program is so popular with landowners here, there is a current backlog of applications on over 47,000 acres.
- [7] Since 1992, Missouri has enrolled approximately 65,000 acres. Landowner interest in WRP continues to far exceed available funding. Currently, 190 tracts, comprising nearly 16,000 acres, are on a prioritized "waiting list" for permanent easements, and 32 tracts, comprising 1700 acres, are waiting for funding in the 30 year easement option.
- [8] New York State is one of the original nine states selected to implement the WRP, resulting in 590 contracts [9] Since its inception in 1992, the WRP has been the conservation tool that has facilitated restoration of more than 16,000

- acres of wetlands. There are currently 10,300 acres offered by landowners in North Carolina awaiting enrollment.
- [10] Oklahoma currently has 60 active WRP projects where restoration efforts are being carried out on 24,293 acres of wetlands and associated buffer areas. The average WRP project size is 405 acres.
 - [11] The State of South Carolina has approximately 12,500 acres currently enrolled and an additional 3,000 acres submitted for restoration.
 - [12] In South Dakota there are 29,561 acres enrolled in WRP permanent and 30-year easements from fiscal year 1994 through February 1999. This total enrollment level resulted from 347 applications. To date, a total of 178 applications have been approved for 15,094 acres and 125 easements are perfected on 9,776 acres. The current backlog of unfunded offers is 33.
 - [13] Texas currently has 27,799 acres enrolled in the WRP program with an additional 4,571 acres in unfunded applications.
 - [14] As of September 7, 2001, there are 30,434 acres enrolled in WRP in Wisconsin. An additional 96 applications on 8,024 acres are on backlog and awaiting funding.

Wetlands Reserve Program (WRP) [California] — California's *Wetland Reserve Program* has focused on the restoration of a variety of wetland types throughout the state, including seasonal wetlands, semi-permanent marsh, vernal pools along the perimeter of the Central Valley, riparian corridors, and tidally-influenced wetlands. The present acreage enrollment, including offers made for 1999, is 47,149 acres with an unfunded backlog of 25,834 acres of perpetual easement applications and 10,984 acres of 30-year easement applications. California reached its highest level of enrollment in fiscal year 1998 with more than 14,000 acres obligated and, from 1998 to the present, doubled the backlog of signed-up acres. The environmental benefits of California's WRP projects primarily focus on habitat for nesting and migrating waterfowl and shorebirds within the Pacific Flyway. In addition, some projects specifically target state and federal threatened and endangered species as well as proposed listed (i.e., threatened or endangered) species such as greater sandhill cranes, Aleutian Canada geese, and various invertebrate and plant species associated with vernal pool wetlands. Riparian projects emphasize the stabilization of stream corridors, expansion of floodplains, and improved water quality benefits. Frequently flooded basin soils converted to wetland habitat provide flood relief, wildlife habitat, and filtering of sediments from adjacent creeks and rivers. Additionally, many WRP easements are used to promote environmental education and research activities. California has utilized partnerships on approximately 75 percent of the easements recorded since 1992, and more than 90 percent of the easements recorded within the past two years. Partnering allows more wetlands to be placed in the program by spreading the financial burden. NRCS has cooperative agreements with Ducks Unlimited and the California Waterfowl Association (CWA) to provide technical and financial assistance for WRP easements, and has enlisted further assistance from CWA to provide administrative assistance related to appraisals, surveys, and recording of easements. Also, NRCS entered into joint easement and/or restoration agreements with the *U.S. Fish and Wildlife Service (USFWS)*, California State Wildlife Conservation Board, *The Nature Conservancy (TNC)*, *U.S. Bureau of Reclamation (BOR)*, and the California Department of Fish and Game.

Wetlands, Seasonal — Wetland areas flooded or taking on the characteristics of a wetland only during specific periods of the year or seasons. Also see *Playa*, *Pan*, and *Prairie Potholes*.

Wetlands, Sediment Deposition — See *Sediment Deposition (Wetlands)*.

Wetlands, Transformation — Man's activities associated with settlement have had profound effects on the nation's wetlands. Water storage and flood control projects have prevented billions of dollars' worth of property damage and countless lost lives. Hydropower, a relatively pollution-free source of electricity, has helped lessen the nation's dependency and consumption of non-renewable energy sources. The ability to deliver millions of gallons of fresh water to the semi-arid regions has been the key to agricultural and industrial productivity in these areas. In the process, however, these activities have transformed the landscape by filling in marshland, dredging bays and harbors, channelizing rivers, reclaiming floodplains, damming rivers, and building railways and highways. The dams and projects for flood control, irrigation and public water supply, have diverted water that had naturally flooded wetlands. The impact on wetlands includes loss of acreage, a significant loss of habitat, degradation of the ecosystem, and the degradation of water quality. The channelization of thousands of miles of natural waterways altered, degraded, and generally destroyed a considerable portion of the nation's available wetlands. Agriculture has affected wetlands as irrigation water carries runoff soil salts and minerals to waterways and ultimately into estuaries and other wetland areas. Runoff and drainage also carry residue fertilizer, pesticides, animal wastes, and any other contaminants present in the soil. This process has contributed to degradation of wetland environments, estuary ecosystems, and water quality in general. In addition, contamination, reduces oxygen levels which jeopardizes animal and plant life and dramatically reduces biodiversity in the system, creating the risk of an even more extreme imbalance.

Wetted Perimeter — (Geology) The length of the wetted contact between a stream of flowing water and its containing conduit or channel, measured in a plane at right angles to the direction of flow.

Wetting Agent — A chemical that reduces the surface tension of water and enables it to soak into porous material more readily.

Wheeling — (1) (General) Carrying or conveying a commodity, such as gas, electricity, and water, to a buyer on behalf of an outside seller. (2) (Water) Using a conveyance system, such as a river, aqueduct, or pipeline, to transport water from a seller, or owner of the water, to a buyer. (3) (Water) the transportation of water, as the result of ad hoc contracts or other arrangements, in

conveyance facilities in which the transferring party does not otherwise have the authority to use.

(Water) Wheeling [Colorado River Basin] — Smaller bodies of water entering into the Colorado River are considered Colorado River water upon contact. This water is then subject to the laws of the *Colorado River Compact*. If the water is diverted prior to reaching the Colorado River, however, it can be separately developed and put to use outside the limitations of the Colorado River Compact. If “wheeling” is approved by the United States federal government, this additional water source could be transferred from one state to another, or within a state, using the Colorado River as a conveyance system.

Whelm — To cover with water; submerge.

Whirlpool — (1) A rapidly rotating current of water; a *Vortex*. (2) An eddy or vortex of water moving rapidly in a circular path and producing a depression in the center, into which floating objects may be drawn. Also see *Coriolis Effect*.

White Eddy — In a river, a *Reversal* below a ledge or other underwater obstruction characterized by a foamy back flow at the surface.

White Ice — Ice that has a whitish color with no discoloration, as when it forms from snow falling on lake or glacier ice.

White Squall — A sudden squall occurring in tropical or subtropical waters, characterized by the absence of a dark cloud and the presence of white-capped waves or broken water.

White Water — (1) Turbulent or frothy water, as in rapids or surf. (2) A popular term for the rough water in ocean breakers or river rapids. (3) Paper mill and pulp mill processing streams consisting of comparatively low concentrations of cellulose fibers in water.

Whitecap — (Oceanography) The froth of bubbles in the crest of a breaking wave.

(Lake) Whitening — A phenomenon which occurs in moderately productive lakes when photosynthetic uptake of carbon dioxide (CO₂) causes the precipitation of small particles of calcite (mostly calcium carbonate, CaCO₃). Since small particles have a greater effect on water transparency and typical calcite particles are only 1–2 micrometers (μm) in diameter, the lake’s water takes on a milky appearance, hence lending to its name.

Whiteout — A polar weather condition caused by a heavy cloud cover over the snow, in which the light coming from above is approximately equal to the light reflected from below, and which is characterized by absence of shadow, invisibility of the horizon, and ability to discern only very dark objects.

Wholesome Water — Water that is safe and palatable for human consumption.

WHP — Wellhead Protection. See *Wellhead Protection (Program)*.

WHPA — See *Wellhead Protection Area*.

Wicket — A sluice gate for regulating the amount of water in a millrace or a canal or for emptying a lock.

Wild and Scenic Rivers (Act) — A national system established under the Wild and Scenic Rivers Act of free-flowing rivers and streams which possess one or more of the following outstanding remarkable values: (1) scenic; (2) recreational; (3) geological; (4) fish and wildlife; (5) historic or cultural; or (6) other values, including biological or ecological. There are three classifications of rivers or river segments – wild, scenic and recreational – with classifications based on the condition of the river and the adjacent lands at the time of the study. The act defines these classifications as follows:

- [1] **Wild River** – Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and water unpolluted, representing vestiges of rivers in primitive America;
- [2] **Scenic River** – Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads;
- [3] **Recreational River** – Those rivers or sections of rivers that are readily accessible by road or railroad that may have some development along their shorelines, and that may have undergone some impoundments or diversions in the past.

Also see *Wild Rivers*, *Scenic Rivers*, and *Recreational Rivers* for permitted activities and restrictions.

Wild Rivers — A classification under the national *Wild and Scenic Rivers Act* to include those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and water unpolluted, representing vestiges of rivers in primitive America. The following represents restrictions applying to such designated rivers:

- [1] **Timber Production** – Cutting of trees is not permitted unless needed in association with a primitive recreation experience (i.e., clearing for trails and protection of users) or to protect the environment (i.e., fire control). Timber outside the boundary but within the visual corridors will be managed and harvested in a manner to provide special emphasis to visual quality.
- [2] **Water Supply** – All water supply dams and major diversions are prohibited.
- [3] **Hydroelectric Power** – No development of hydroelectric power facilities would be permitted.
- [4] **Flood Control** – No flood control dams, levees, or other works are allowed in the channel or river corridor. The natural appearance and essentially primitive character of the river areas must be maintained.
- [5] **Mining** – New mining claims and mineral leases are prohibited within one-quarter mile of the river. Valid claims

would not be abrogated. Subject to regulations (i.e., 36 CFR 228) that the Secretaries of Agricultural and Interior may prescribe to protect the rivers included in the National System, other existing mining activity must be conducted in a way that minimizes surface disturbance, sedimentation, and visual impairment. Reasonable access will be permitted.

- [6] **Road Construction** – No roads or other provisions for overland motorized travel would be permitted within a narrow incised river valley or, if the river valley is broad, within one-quarter mile of the river bank. A few inconspicuous roads leading to the boundary of the river area at the time of the study will not disqualify wild river classification. Also, unobtrusive trail bridges could be allowed.
- [7] **Agriculture** – Agricultural use is restricted to a limited amount of domestic livestock grazing and hay production to the extent currently practiced. Row crops are prohibited.
- [8] **Recreational Development** – Major public-use areas, such as large campgrounds, interpretive centers, or administrative headquarters are located outside the wild river area. Simple comfort and convenience facilities, such as fireplaces or shelters may be provided as necessary within the river area. These should harmonized with the surroundings.
- [9] **Structures** – A few minor existing structures could be allowed assuming such structures are compatible with the essentially primitive and natural values of the viewshed. New structures would not be allowed except in rare instances to achieve management objectives. Structures and activities associated with fisheries enhancement programs could be allowed.
- [10] **Utilities** – New transmission lines, gas lines, water lines, etc., are discouraged. Where no reasonable alternative exists, additional or new facilities should be restricted to existing right-of-way. Where new rights-of-ways are indicated, the scenic, recreation, and fish and wildlife values must be evaluated in the selection of the site.
- [11] **Motorized Travel** – Motorized travel on land or water could be permitted, but is generally not compatible with this classification.

Also see *Wild and Scenic Rivers Act*, *Scenic Rivers*, and *Recreational Rivers*.

Wilderness — Undeveloped land and associated water resources retaining their primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural condition and that (1) generally appears to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) is of sufficient size so as to make practical its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Wilderness Act — A 1964 Act of Congress which established federal *Wilderness Areas*. As defined under this act, wilderness is undeveloped federal land without permanent improvements or human habitation; is protected and managed so as to preserve its natural conditions; has outstanding opportunities for solitude or primitive recreation; has at least 5,000 acres or is of sufficient size to make practical its condition; and may contain features of scientific, educational, scenic, or historical value as well as ecologic and geologic interest.

Wilderness Area — Land where the effects of man are not apparent. Large tracts of land that are set aside and allowed to develop without the intervention of man. Such activities as the construction of roads, development of recreational facilities, removal of trees, or hunting are prohibited. The 1964 *Wilderness Act* allows the U.S. government to set aside sections within the national forests, national parks, and national wildlife refuges as wilderness areas. Currently there are about 450 such areas within the United States totaling 90 million acres, two-thirds of which are in Alaska.

(The) Wilderness Society — An American environmental organization concerned with the protection of wildlife habitat and wildlife refuges as well as the preservation of public lands.

Wilderness Study Area (WSA) — An area possessing wilderness characteristics as defined in the *Wilderness Act*, an identified pursuant to the *Federal Land Policy and Management Act* of 1976. These areas are maintained in their original condition and evaluated for possible inclusion in the *National Wilderness Preservation System*.

Wilderness Values — Values established in the *Wilderness Act*, such as solitude and naturalness.

Wildland — A non-urban, natural area which contains uncultivated land, timber, range, watershed, brush or grassland.

Wildlife Habitat Complexity (WHC) — (Ecology) A measure of the habitat heterogeneity of a site, based on the comparison of the number of sub-habitat types present at a site relative to the number of possible sub-habitats known to occur in the appropriate regional reference standard site. Also see *Biodiversity*.

Wildlife Management Areas (WMAs) [Nevada] — Nevada's Wildlife Management Areas (WMAs) are lands and waters which have been acquired to effectuate a coordinated and balanced program resulting in the maximum revival of fish and wildlife and in the maximum recreational advantages to the people of the State of Nevada. Lands in Nevada set aside as WMAs currently total almost 275,000 acres (429 square miles). State WMAs are subject to supervision by the Nevada Board of Wildlife Commissioners. The following areas have been so designated and are identified by *Nevada Division of Wildlife (NDOW)* geographic region:

Region I:

- [1] **Stillwater Wildlife Management Area** – Located in Churchill County, initially established in 1948 as a Tri-Party Agreement among TCID, USFWS, and NDOW and subsequently in 1960 as a Two-Party Agreement between USFWS and NDOW, consists of 143,866 acres of lands under joint management by NDOW AND USFWS.
- [2] **Mason Valley Wildlife Management Area** – Located in Lyon County, initially established on March 26, 1955 with land acquisitions continuing through September 9, 1993, consists of 13,178 acres of owned land.
- [3] **Scripps Wildlife Management Area** – Located in Washoe County, initially established on March 20, 1957 with additional acquisitions through May 11, 1994, consists of 2,451 acres of owned land.
- [4] **Fernley Wildlife Management Area** – Located in Lyon and Churchill counties, initially established in 1952, consists of 13,019 total acres including 5,339 acres owned and 7,680 acres leased (USBR and TCID).
- [5] **Humboldt Wildlife Management Area** – Located in Pershing and Churchill counties, initially established on June 22, 1956 with land acquisitions continuing through June 15, 1982, consists of 36,336 total acres including 160 acres owned and 36,176.04 acres leased ((USBR and SPLC).
- [6] **Alkali Lake Wildlife Management Area** – Located in Lyon County, established on April 9, 1965 and consists of 3,448 acres of withdrawn land (USBR).
- [7] **Sleeper Wildlife Management Area** – Located in Humboldt County, established on November 17, 1989 and consists of 3,553 acres of withdrawn land (Nevada Gold Mining, Inc. and BLM).
- [8] **Lagomarsino Wildlife Management Area** – Located along the Truckee River in Storey County, initially established on April 10, 1978, consists of 120 acres of owned land donated by the federal government (GSA).

Region II:

- [9] **Kingston Canyon Wildlife Management Area** – (Includes the Birch Creek Unit) Located in Land County, initially established in 1967 and consists of 120 acres of owned land including the site of the Kingston Dam on Kingston Creek.
- [10] **Cave Lake Wildlife Management Area** – (Includes the Willow Creek Unit) Located in White Pine County, initially established in 1972 and consists of 1,325 acres of owned land under management agreement between NDOW and NDSP.
- [11] **Franklin Lake Wildlife Management Area** – Located in the southern portion of Elko County, initially established on June 20, 1988 and consists of 3,229 total acres of owned land (purchased from TNC).
- [12] **Bruneau River Wildlife Management Area** – Located in the northern portion of Elko County, initially established on June 28, 1991 and consists of 4,771 total acres of owned land (purchased from RMEF).

Region III:

- [13] **Overton Wildlife Management Area** – Located in Clark County, initially established August 8, 1969 with land acquisitions continuing through March 25, 1975, consists of 17,657 total acres with 3,082 acres owned and 14,575 acres leased (NPS and USBR).
- [14] **Wayne E. Kirch Wildlife Management Area** – Located in Nye County, initially established on April 10, 1959 with land acquisitions continuing through August 27, 1964, consists of 14,815 total acres with 9,222 acres owned and 5,593 acres withdrawn (BLM).
- [15] **Key Pittman Wildlife Management Area** – Located in Lincoln County, initially established on July 23, 1962 with additional acquisitions (BLM and R&PP) continuing through April 12, 1993, consists of 1,337 acres of owned land.
- [16] **Railroad Valley Wildlife Management Area** – Located in Nye County, initially established in 1968 and consists of 14,720 acres of withdrawn land (BLM) under a management agreement between BLM and NDOW.
- [17] **Schroeder Reservoir Wildlife Management Area** – Located in Lincoln County, initially established in 1960 and consists of 28 acres of NDSP-owned land managed by agreement between NDSP and NDOW.
- [18] **Eagle Valley Wildlife Management Area** – Located in Lincoln County, initially established in 1970, consists of 349 acres state-owned land and managed by agreement between NDSP and NDOW.

Nevada's *Cooperative State Wildlife Management Areas* are areas established by agreement with private owners in order to provide a greater opportunity for the public to hunt, fish, trap, camp, boat or participate in other compatible recreational activity on private lands and to protect the landowner or lessee from damage due to trespass or excessive pressure. The following area has been so designated within Nevada:

- [19] **Fort Churchill Cooling Pond Cooperative Wildlife Management Area** – Located in Lyon County, initially established in 1969 and consists of 92 acres of land owned by SPPCo including cooling ponds and adjacent wetlands managed by NDOW.

[Explanation of agency acronyms used above: BLM = Bureau of Land Management; GSA = General Services Administration; NDOW = Nevada Division of Wildlife; NDSP = Nevada Division of State Parks; NPS = National Park Service; R&PP = Recreation and Public Purpose Act – BLM Land Patent Process; RMEF = Rocky Mountain Elk Foundation; SPLC = Southern

Pacific Land Company; SPPCo = Sierra Pacific Power Company; TCID = Truckee–Carson Irrigation District; TNC = The Nature Conservancy; USBR = U.S. Bureau of Reclamation; USFWS = U.S. Fish and Wildlife Service.]

Wildlife Refuge — An area designated for the protection of wild animals, within which hunting and fishing are either prohibited or strictly controlled.

(National) Wildlife Refuge (NWR) System — See *National Wildlife Refuge (NWR) System* and *National Wildlife Refuges (NWR) [Nevada]*.

Will — Indicates a requirement that is necessary or essential to meet the current Federal rules and regulations or other accepted standards of protection.

Wilting Capacity — (Ecology) The amount of water remaining in the soil when a plant is permanently wilted.

Wilting Point — (1) The soil moisture content at which the permanent wilting of plants occurs. (2) The minimum quantity of water in a given soil necessary to maintain plant growth. When the quantity of moisture falls below this point, the leaves begin to droop and shrivel up. In any given soil the minimum quantity is practically constant for all plants, but it increases with a decrease in the size of soil particles. (3) The tension at which water is held in the soil beyond which plants (normally) cannot withdraw soil moisture.

Wilting Point, Ultimate — The point at which the moisture content of the soil is such that all the leaves of plants growing in it are completely wilted and will not recover without the addition of water.

Wimple — A ripple, as on the surface of water.

Wind — Moving air.

Wind Crust — A snow crust formed by the packing of previously deposited snow into a hard layer as a result of wind action.

Wind Scale — A systematic arrangement of words and/or numbers used for expressing and recording the velocity or force of the wind. The U.S. Weather Bureau scale uses a graduation of 13 scales [0–12] to represent different wind conditions. These wind conditions, along with corresponding wind speeds (in miles per hour) and the scale number are presented in the following table:

Wind Condition	Wind Speed (mph)	Scale Number (0-12)
Light	Less than 1	0
	1 - 3	1
	4 - 7	2
Gentle	8 - 12	3
Moderate	13 - 18	4
Fresh	19 - 24	5
Strong	25 - 31	6
	32 - 38	7
Gale	39 - 46	8
	47 - 54	9
Whole Gale	55 - 63	10
	64 - 75	11
Hurricane	Above 75	12

Also see *Beaufort's Scale*.

Wind Slab (or Windslab) — A layer of snow that is compacted tightly by the wind as the snow is falling.

Wind-Slab Avalanche — A type of avalanche initiated by the breaking off of a large wind slab from the underlying snow.

Window — (1) A part of a river that remains unfrozen during all or part of the winter although it is completely surrounded by river ice. (2) (Geology) An area in which erosion has effected a thrust or recumbent fold, exposing the underlying rock.

Window Frost — See *Window Ice*.

Window Ice — A thin deposit of ice crystals that forms when water condenses on the interior of a cold window surface and then freezes. Similar to *Window Frost*.

Windows of Access — Refers to discrete time periods when flow conditions are suitable for fish migration in a channel or into or out of tributaries.

Windstorm — A storm with high winds or violent gusts but little or no rain.

Wingdam — A wall, crib, row of pilings, stone jetty, or other barrier projecting from the bank into a stream for protecting the bank from erosion, arresting sand movement, or for concentrating the low flow of a stream into a smaller channel.

Wing Wall — The side walls of a structure used to prevent sloughing of banks or channels and to direct and confine overfall.

Winter Balance — The change in mass of a glacier from its minimum value of a given year to the maximum value of that year.

Winter Irrigation — The irrigation of lands between growing seasons in order to store water in the soil for subsequent use by plants.

Winter Kill — The complete or partial kill of fish and other animals in a body of water, usually occurring during prolonged periods

of ice and snow cover. The kill can be attributed to a number of circumstances including diminished dissolved oxygen due to a lack of photosynthesis; the depletion of dissolved oxygen by decomposing organic matter; the production of harmful chemicals (e.g., ammonia, hydrogen sulfide, and ethanes) resulting from anaerobic decomposition; and the harmful influence of insecticides and herbicides.

Winter Pool — The pool, or height of the water surface, of a reservoir during the winter. This pool is usually a specific height and is maintained for the control of late winter and spring flooding. It is usually lower than the summer pool.

Winter Range — Areas used by migratory wildlife during the winter months. Typically these areas are low in elevation and have a shrub layer available to provide cover and forage.

Winter Storm Warning — A warning issued by the *National Weather Service (NWS)* when heavy snow (6 inches (15 cm) in 12 hours or 8 inches (20 cm) in 24 hours and considerable blowing and drifting), blizzard conditions (sustained wind speeds or frequent gusts of 35 mph (16 meters/second) or higher, considerable falling and/or blowing snow reducing visibilities to less than ¼-mile, and low temperatures) and/or significant accumulations of freezing rain or sleet (greater than ¼-inch) are imminent or occurring. These criteria are specific for the Midwestern United States and may vary regionally.

Winter Weather Advisory — An advisory issued by the *National Weather Service (NWS)* when a mixture of precipitation such as snow, sleet, freezing rain or drizzle is imminent or occurring.

Winters Doctrine — The doctrine of (federal) reservation rights. See *Winters Rights (Decision)*.

Winters Rights (Decision) — The U.S. Supreme Court precedent decision (*Winters v. United States*, 207 U.S. 564 [1908]) in which the Court prohibited any uses by non-Indians that interfered with the Indian tribes' use of their reserved water. In *Winters*, the Court held that when reservations were established, Indian tribes and the United States implicitly reserved, along with the land, sufficient water to fulfill the purposes of the reservations. The ruling rests on the principle that Indian tribes retain all rights not explicitly relinquished. These federal reserved water rights are commonly known as *Winters Rights* as based on the *Winters Doctrine*. The court recognized these rights as having a priority date coinciding with the date the reservation was established, thus providing a means to integrate federally reserved rights with *Appropriative Water Rights* recognized under state law. Since reserved rights are not created by state law, *Winters Rights* retain their validity and seniority regardless of whether tribes have put the water to *Beneficial Use*. On-going conflicts concerning this ruling tend to involve non-Indian water users appropriating water under state law, water that previously may have been reserved for Indian tribes, though never quantified by courts or fully used on reservations. Also see *Reservation Doctrine*, *Reserved Rights Doctrine*, and *Winters Doctrine*, *Practically Irrigable Acreage (PIA)*, *(Prior) Appropriation Doctrine*, and *Water Law [Federal]*.

Wire-to-Water Efficiency — The efficiency of a pump and motor together. Also referred to as the *Overall Efficiency*.

Wisconsin — (Geology) Of or relating to one of the glacial stages of the *Pleistocene* epoch which occurred in North America, which consisted of the *Nebraskan* (first stage), *Kansan* (second stage), *Illinoian* (third stage), and *Wisconsin* (fourth stage).

Witch — To use a divining rod to find underground water or minerals; *Dowse*.

Withdrawal — (1) The process of taking water from a source and conveying it to a place for a particular type of use. (2) Diversion for beneficial use.

Withdrawal, Water — Water diverted from the ground or diverted from a surface-water source for use. It may be *Consumptively* or *Nonconsumptively* used, beneficially or nonbeneficially used, or returned in part for reuse. See also *Consumptive Use*, *Nonconsumptive Use*, and *Beneficial Use*.

Withdrawal Use — Use which requires that the water be removed from the ground or diverted from a stream or lake. This type includes irrigation, domestic, stock, public supply, electric power and industrial uses. The quantity of water withdrawn at a designated place for use is variously referred to as pumpage, water intake, duty of water, or water requirement.

Woodland — (1) Any land used primarily for growing trees and shrubs. Woodland includes, in addition to what is ordinarily termed "forest" or "forest plantations", shelterbelts, windbreaks, wide hedge rows containing woodland species for wildlife food or cover, stream and other banks with woodland cover, etc. Also includes farmland and other lands on which woody vegetation is to be established and maintained. (2) An area or biotic community dominated by widely-spaced trees of short stature growing on warm, dry sites. In the Southwest United States, common woodland species are oak, pinyon, and juniper; these woodlands usually occur below 8,000 feet elevation.

Woodland Management — The management of *Woodlands* and plantations that have passed the establishment stage, including all measures designed to improve the quality and quantity of woodland growing stock and to maintain litter and herbaceous ground cover for soil, water, and other resource conservation. Some of these measures are planting, improvement cutting, thinning, pruning, slash disposal, and protection from fire and grazing.

Woody Debris — Coarse wood material such as twigs, branches, logs, trees, and roots that fall into streams.

Woody Plant — A seed plant (*Gymnosperm* or *Angiosperm*) that develops persistent, hard, fibrous tissues, basically xylem; e.g., trees and shrubs.

World Wildlife Fund (WWF) — Recognized worldwide by its panda logo, the World Wildlife Fund is dedicated to protecting the world's wildlife and wildlands. The WWF is the largest privately supported international conservation organization in the world, with more than 1 million members in the United States alone. Since its inception in 1961, WWF has invested in over 13,100 projects in 157 countries. WWF directs its conservation efforts toward three global goals:

- [1] Protecting endangered spaces;
- [2] Saving endangered species; and
- [3] Addressing global threats.

From working to save the giant panda, the tiger, and the rhino, to helping establish and manage parks and reserves worldwide, WWF has been a conservation leader for 40 years. Part of the WWF's scientific analysis of wildlife and habitats has dealt with the delineation of the world's habitats in terms of "Ecoregions." Within each ecoregion, specific classification and sub-classification breakouts are made, i.e., Tropical & Subtropical Moist Broadleaf Forests are further defined as rain forests, lowland rain forests, moist deciduous forests, montane rain forests, lowland rain forests, lowland rain and freshwater swamp forests, tropical rain forests, etc. Including the surrounding and inclusive bodies of water, the WWF world's EcoRegions include:

- [1] Australasia – Australia, New Zealand, New Guinea;
- [2] Antarctic – Antarctica;
- [3] Afrotropic – Central and South Africa;
- [4] Indo-Malayan – India and Southeast Asia;
- [5] Nearctic – North American and Mexico;
- [6] Neotropic – Central and South America;
- [7] Oceania – Pacific Ocean Islands; and
- [8] Palearctic – Europe, Asia, and Northern Africa.

As a further breakout, for example, the ecoregions of Australasia may be sub-categorized as:

- Tropical & Subtropical Moist Broadleaf Forests
- Tropical & Subtropical Dry Broadleaf Forests
- Temperate Broadleaf & Mixed Forests
- Tropical & Subtropical Grasslands, Savannas, & Shrublands
- Temperate Grasslands, Savannas & Shrublands
- Montane Grasslands and Shrublands
- Tundra
- Mediterranean Forests, Woodlands, & Shrub
- Deserts & Xeric Shrublands
- Mangrove

“Worst Drought of Record” — The series of (water) years when water supply and hydrologic conditions represented the least ever recorded.

WRID — See *Walker River Irrigation District (WRID) [Nevada]*.

Wringer — One that wrings, especially a device in which laundry is pressed between rollers to extract water.

WWTP — Wastewater Treatment Plant.

X

Xenobiota — *Biota* displaced from its normal habitat; a chemical foreign to a biological system.

Xeric — (Ecology) (1) Describing a location or habitat with very little moisture. (2) Describing an organism that lives in such an environment. (3) Describing an organism that requires little moisture or a habitat containing little moisture; dry environmental conditions as compared to *Hydric* (wet environmental conditions) and *Mesic* (moderate environmental conditions).

Xeric Shrubs — Shrubs that are adapted to survive in areas of low precipitation. Common to Mediterranean climates that have moist cool winters and warm dry summers. A limited amount of moisture is present but does not occur at optimum periods for plant growth. Irrigation or summer fallow is commonly necessary for crop production.

Xeriscape™ — Landscaping with native and naturalized plant species that are adapted to survive in areas of low precipitation. [Trademark Note: The term “Xeriscape” is a trademark of the National Xeriscape Council, Inc., and accordingly must always be capitalized, must always be used the first time with a “™” symbol, and can only be used as an adjective, e.g., Xeriscape landscaping, a Xeriscape garden, etc.]

Xerophilous — (Ecology) Living or thriving in dry habitats; drought-tolerant. Thus, *Xerophile* and *Xerophily*.

Xerophyte — (1) Any plant growing in a habitat in which an appreciable portion of the rooting medium dries to the wilting coefficient at frequent intervals. A drought resistant plant; a plant which grows in arid areas. (2) (Ecology) A plant that lives in an area with little moisture. Thus, *Xerophytic*.

X–Year Flood — The magnitude of a flood which has a 1-in-*X* chance of being exceeded in any future one-year period. For example, a 2–year flood would have a 1-in-2 (50 percent) chance of exceedence in any one year; a 10–year flood, a 1-in-10 (10 percent) chance; a 100–year flood, a 1-in-100 (1 percent) chance, etc. These values are statistically derived, using past flood records. They are used for many reasons, but especially for engineering drainage and water supply structures. As the occurrence of floods is random in time, there is no guarantee that there will not be two *X*–year floods within a given year. There is also no guarantee that there will be an *X*–year flood in an *X*–year time period, or even in a 2*X* period. Finally, an *X*–Year, *Y*–Duration Rain will not necessarily produce an *X*–year flood. Storm duration and intensity, antecedent moisture and other conditions can cause *X*–year rains to produce more or less than *X*–year floods. For example, a 100–year, 6–hour rain over a very dry basin may only produce a 2–year flood, whereas a 5–year, 6–hour rain over a saturated or burned basin could cause a 100–year flood. Also see *Hundred Year Flood*.

X–Year, Y–Duration Rain — The magnitude of rainfall which has a 1-in-*X* chance of being exceeded in any future one-year time period with a duration of *Y* [hours or days]. *X*–year rains must have durations associated with them; e.g., 25–year, 6–hour rain, 50–year, 24–hour rain, 100–year, 10–day rain, etc. These values are statistically derived using past rainfall records. Also referred to as *Rainfall Duration-Frequency*. Also see *X–Year Flood*.

Xylem — The supporting and water-conducting tissue of *Vascular Plants*, consisting primarily of tracheids and vessels; woody tissue.

Y

Yazoo (or Yazoo Stream) — A tributary flowing along the base of a natural levee formed by the main stream before joining it at a considerable distance downstream. (From a noted example of this type of tributary, the Yazoo River, which joins the Mississippi River at Vicksburg.)

Yellow Mud — (Geology) A type of mud characterized by a yellow color resulting from the presence of iron compounds.

Yellow Rain — A powdery, poisonous, yellow substance reported as dropping from the air in southeast Asia and found to be the excrement of wild honeybees contaminated by a fungal toxin.

Yellow Snow — Snow that has a yellowish tint, as from the presence of certain yellow-green algae.

Yellowboy — Iron oxide flocculent (clumps of solids in waste or water); usually observed as orange-yellow deposits in surface streams with excess iron content. Characterized by unsightly yellowish precipitates of ferric sulfate and hydroxide and frequently observed in many streams polluted by mine drainage.

Yield — (1) The quantity of water expressed either as a continuous rate of flow (e.g., cubic feet per second – cfs) or as a volume per unit of time (e.g., acre-feet per year – AFY) which can be collected for a given use or uses from surface water or groundwater sources on a watershed. The yield may vary with the use proposed, with the plan of development, and also with economic considerations. (2) Total runoff. (3) The streamflow in a given interval of time derived from a unit area of watershed. It is determined by dividing the observed streamflow at a given location by the drainage area above that location and is usually expressed in cubic feet per second per square mile.

Yield, Average Annual — The average annual supply of water produced by a given stream or water development.

Yield, Firm — The maximum annual supply of a given water development that is expected to be available on demand, with the understanding that lower yields will occur in accordance with a predetermined schedule or probability. Sometimes referred to as *Dependable Yield*.

Yield, Gross (Water) — (1) The available water runoff, both surface and subsurface, prior to use by man's activities, use by *Phreatophytes*, or evaporation from free water surfaces. (2) The estimated or actual available water, both surface and sub-surface, prior to agricultural and phreatophytic use. Generally, this water yield is estimated for a stream or streams at a point above the highest diversion for the main body of irrigated land on a flood plain of a valley.

Yield, Perennial — The amount of usable water of a ground-water reservoir that can be economically withdrawn and consumed each year for an indefinite period of time. It cannot exceed the sum of the *Natural Recharge*, the *Artificial (or Induced) Recharge*, and the *Incidental Recharge* without causing depletion of the groundwater reservoir. Also referred to as *Safe Yield*.

Yield, Safe — With reference to either a surface water or groundwater supply, the rate of diversion or extraction for *Consumptive Use* which can be maintained indefinitely, within the limits of economic feasibility, under specified conditions of water-supply development. Also see *Perennial Yield*.

Young — (Geology) Being of an early stage in a geologic cycle. Used of bodies of water and land formations.

Young Ice — Newly formed, floating, flat sea ice in the stage following nilas. Also referred to as *Fresh Ice*.

Youth — (1) The stage at which the erosion of the stream channel has just begun in the development of a stream; characterized by increasing vigor and by the ability to carry a greater load than the stream is already carrying. (Geology) (2) The first stage in the cycle of erosion in the topographic development of a landscape or area; characterized by the dominance of the original surface or structural features. Also referred to as *Topographic Youth*. (3) The stage characterized by an ungraded profile of equilibrium in the development of a shore or coast.

Z

Zebra Mussel — The zebra mussel, a freshwater Eurasian lamellibranch mollusk (*Dreissena polymorpha*), is a marine shellfish which was first discovered in the Great Lakes of the United States in 1988 and is believed to have arrived in North America by being carried in the ballast water of a cargo vessel. Since the first discovery of this exotic species, they have spread rapidly through North American surface waters, particularly throughout the Great Lakes and Mississippi River basins and their navigable tributaries. As of March 1996, zebra mussels were resident in nineteen states and two Canadian provinces. Zebra mussels can cause severe fouling of municipal drinking water, electric power generation, and industrial water systems; they are also harmful to aquatic ecosystems, boating and navigation, agricultural irrigation equipment, aquacultural equipment, and recreational beach use.

Zeta Potential — (Water Quality) (1) In coagulation and flocculation procedures, the difference in the electrical charge between the dense layer of ions surrounding the particle and the charge of the bulk of the suspended fluid surrounding this particle. The zeta potential is usually measured in millivolts. (2) In a *Colloidal* system, the difference in potential between the immovable layer attached to the surface of the dispersed phase and the dispersion medium. It is related to particle stability and therefore is a useful parameter in coagulation operations.

Zeolite — (1) (Geology) Any of various hydrous silicates that are analogous in composition to the feldspars, occur as secondary minerals in cavities of lavas, and can act as an ion-exchanger. (2) (Chemistry) Also, any of various natural or synthesized silicates of similar structure used especially in water softening and as an adsorbent and catalyst. (3) (Water Quality) A type of ion exchange material used to soften water. Natural zeolites are siliceous compounds which remove calcium and magnesium from hard water and replace them with sodium. Synthetic or organic zeolites are ion exchange materials which remove calcium or magnesium and replace them with either sodium or hydrogen. Manganese zeolites are used to remove iron and manganese from water.

Zero Discharge — The goal, in the preamble to the *Clean Water Act (CWA)*, of zero pollutants in water discharges.

Zero Population Growth — (Environmental) The maintenance or holding of population numbers at a fixed level so as to obviate increase and mitigate pressures on infrastructure, resources, pollution, etc.

Zeta Potential — (Wastewater Treatment) In coagulation and flocculation procedures, the difference in the electrical charge between the dense layer of ions surrounding the particle and the charge of the bulk of the suspended fluid surrounding this particle. The zeta potential is usually measured in millivolts.

Zingg Bench Terrace — A special type of bench terrace designed for dryland moisture conservation. Typically employs an earthen embankment similar to the ridge terrace; a part of the terrace interval immediately above the ridge is bench-leveled. Runoff water from the sloping area is retained on the leveled area and absorbed by the soil. Also see *Terrace*.

Zone — (1) (Ecology) An area characterized by similar flora or fauna; a belt or area to which certain species are limited. (2) (Engineering) In earth dams, a segment of the earthfill containing similar materials; earth structures may be divided into two or more segments or zones to make the best use of available materials.

Zone of Ablation — See *Ablation Area*.

Zone of Accumulation — The combination of the *A-Horizon* and the *B-Horizon*.

Zone of Aeration — The comparatively dry soil or rock located between the ground surface and the top of the *Water Table*. A zone immediately below the surface of the ground, in which the openings are partially filled with air, and partially with water trapped by molecular attraction. Generally subdivided into: (a) belt of soil moisture; (b) intermediate belt; and (c) capillary fringe. Also referred to as the *Unsaturated Zone* or the *Vadose Zone*.

Zone of Contribution (ZOC) — The area surrounding a pumping well that encompasses all areas or features that supply groundwater recharge to the well.

Zone of Eluviation — The two uppermost zones in the soil profile, consisting of the *A-Horizon*, from which soluble *Salts* and *Colloids* are leached, and in which organic matter has accumulated and generally constitutes the most fertile soil layer, and the *B-Horizon*, or the lower soil zone which is enriched by the deposition or precipitation of material from the overlying zone, or *A-horizon*. Also referred to as the *Solum*.

Zone of Engineering Control — The area occupied by a hazardous waste treatment, storage, or disposal facility which the owner or operator can readily decontaminate if a leak is detected, thus preventing hazardous waste or its constituents from entering groundwater of surface water.

Zone of Influence (ZOI) — (1) The area surrounding a pumping well within which the water table or *Potentiometric Surfaces* has been changed due to groundwater withdrawal. (2) (Environmental) The geographic area whose social, economic, and/or environmental conditions is significantly affected by changes in the study area.

Zone of Initial Dilution (ZID) — That area within a lake or stream where the discharge from an outfall first mixes with the receiving water.

Zone of Net Metabolic Production — (Biology) The region (or depth) of a body of water in which constructive metabolism (*Anabolism* or *Assimilation*) is equal to or greater than destructive metabolism (*Catabolism* or *Dissimilation*). *Metabolism* is the sum of the processes concerned in the building up of protoplasm and its destruction incidental to life; the chemical changes in

living cells, by which the energy is provided for the vital processes and activities, and new material is assimilated to repair the waste. Metabolism may be considered as including two aspects or processes: constructive metabolism (anabolism) or destructive metabolism (catabolism). Anabolism and Catabolism go on together, but one may predominate and obscure the other. Below this level (the *Compensation Level*), the destructive process tend to exceed the constructive processes. Also referred to as the *Photic Zone*.

Zone of Saturation — (1) The soil or rock located below the top of the groundwater table. By definition, the zone of saturation is saturated with water. Also see *Water Table*. (2) Underground region within which all openings are filled with water. The top of the zone of saturation is called the water table. The water that is contained within the zone of saturation is called *Groundwater*.

Zone of Transport (ZOT) — The area surrounding a pumping well, bounded by an Isochrone and/or isoconcentration contour, through which a contaminant may travel and reach the well.

Zoning — The partition of a city, county, township, or other governmental unit or area by ordinance into sections reserved for different land-use purposes, such as residential, business, manufacturing, greenbelt, or agriculture.

Zooglea — (Water Quality) A jelly-like matrix developed by bacteria which is abundant in activated sludge flocs and trickling filter slimes.

Zoogleal Film — (Wastewater Treatment) A complex population of organisms that form a “slime growth” on the trickling filter media and break down the organic matter in wastewater. These slimes consist of living organisms feeding on the wastes in wastewater, dead organisms, silt, and other debris. “Slime growth” is a more common term.

Zoogleal Mass — (Wastewater Treatment) Jelly like masses of bacteria found in both the trickling filter and *Activated Sludge Processes*. These masses may be formed for or function as the protection against predators and for storage of food supplies. Also see *Biomass*.

Zoogleal Mat — (Wastewater Treatment) A complex population of organisms that form a “slime growth” on the sand filter media and break down the organic matter in wastewater. These slimes consist of living organisms feeding on the wastes in wastewater, dead organisms, silt, and other debris. On a properly loaded and operating sand filter these mats are so thin as to not be visible to the naked eye. “Slime growth” is a more common term.

Zoology — The branch of *Biology* that studies animals, including their structure, function, growth, origin, evolution, and distribution.

Zooplankton — (1) Small, usually microscopic animals (such as *Protozoans*) found in lakes and reservoirs that possess little or no means of propulsion. Consequently, animals belonging to this class drift along with the currents. (2) The animal part of the plankton. Zooplankton are capable of extensive movements within the water column and are often large enough to be seen with the unaided eye. Zooplankton are secondary consumers feeding upon bacteria, phytoplankton, and detritus. Because they are the grazers in the aquatic environment, the zooplankton are a vital part of the aquatic food web. The zooplankton community is dominated by small crustaceans and *Rotifers*.

Zooxanthellae — A plant-like algae that lives inside living *Coral* polyps and perform photosynthesis, producing food which is shared with the coral. Virtually all reef-dwelling corals have a symbiotic (mutually beneficial) relationship with zooxanthellae. Zooxanthellae account for up to 75 percent of the biomass of reef-building corals and also provide the coral with up to 90 percent of its nutrition. In exchange, the coral provides the algae with protection and access to light, which is necessary for its photosynthesis. The zooxanthellae also lend their color to their coral symbionts. See *Coral Bleaching*.