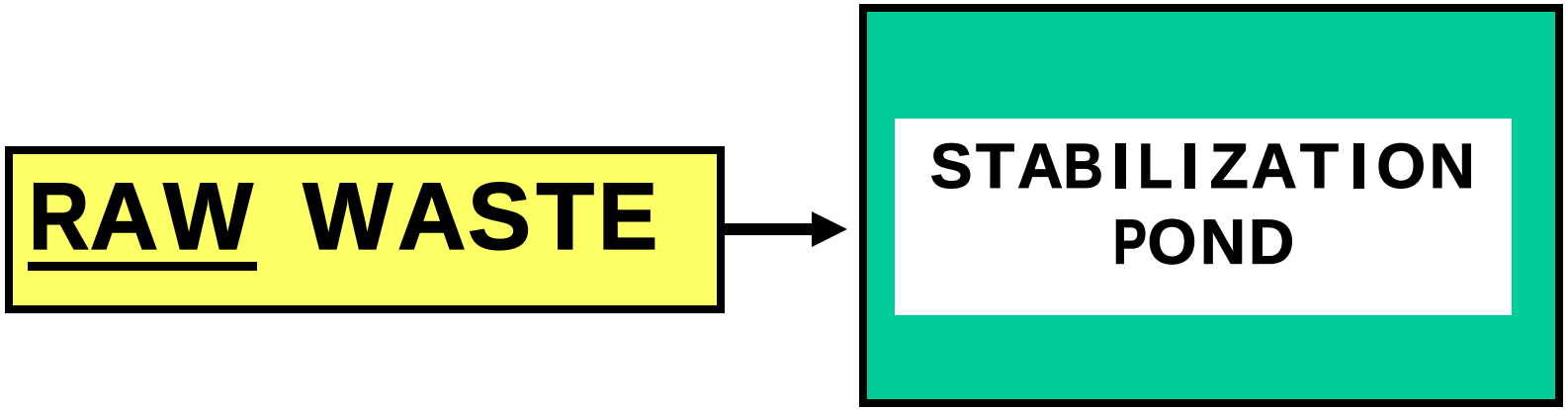
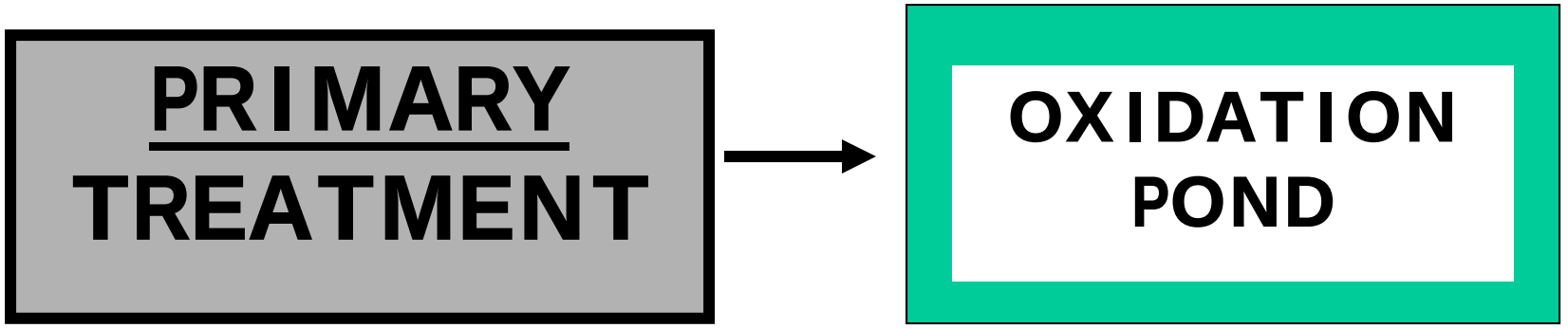
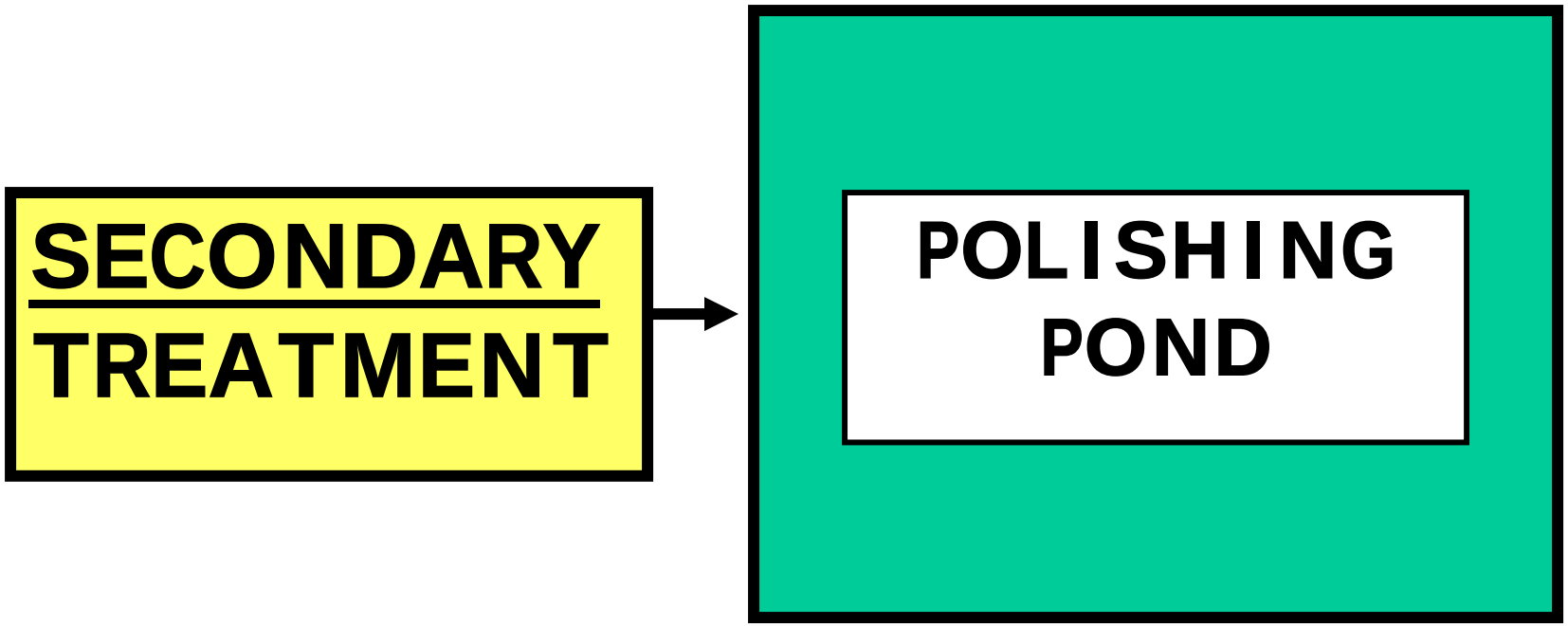
WASTE TREATMENT PONDS HAD THEIR BEGINNING IN ENGLAND IN THE MID-1800's

WASTE TREATMENT PONDS





WASTE TREATMENT PONDS



PONDS HAVE BEEN DESIGNED AND BUILT IN THIS COUNTRY FOR ABOUT 50 YEARS

- NO EXPENSIVE EQUIPMENT
- EASY TO CONSTRUCT & OPERATE
- LOW ENERGY USAGE/ NO SLUDGE
- WILDLIFE HABITAT/REFUGE

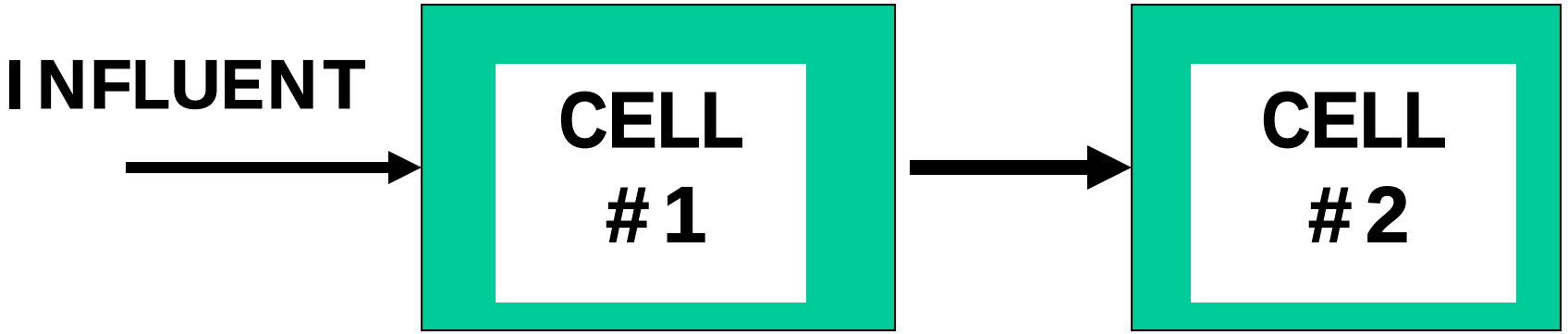
DISADVANTAGES OF PONDS

- REQUIRE LARGE LAND AREA
- MAY EMIT ODORS
- MAY CONTAMINATE GROUNDWATER
- MAY HAVE HIGH SUSPENDED SOLIDS IN THE EFFLUENT

OVER 7,000 PONDS IN USE IN THE UNITED STATES

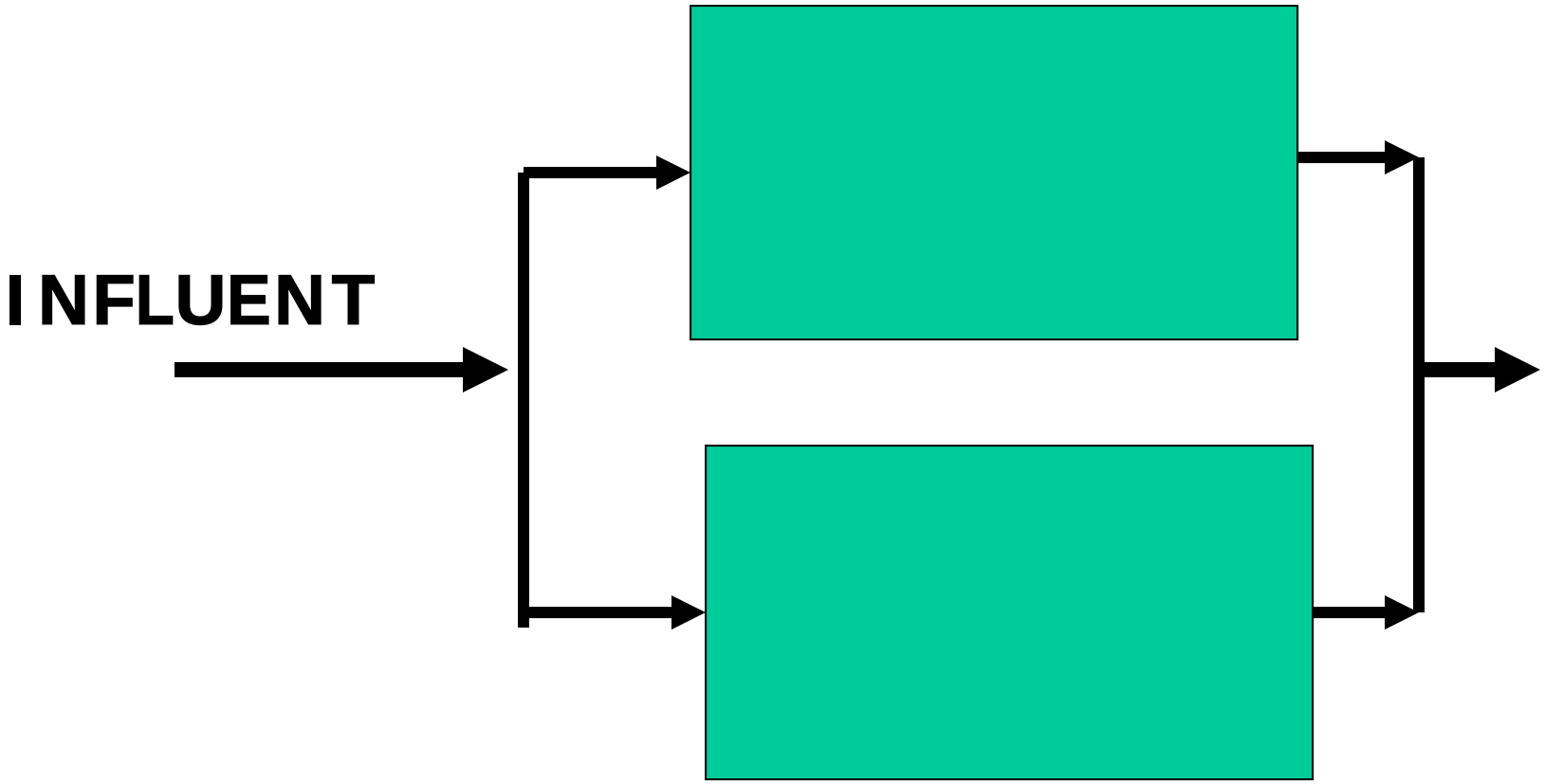
AT ONE TIME, MELBOURNE, AUSTRALIA USED 28,000 ACRES OF PONDS TO TREAT 130 MILLION GALLONS PER DAY OF WASTEWATER

PONDS IN SERIES



CAN PRODUCE A HIGH QUALITY EFFLUENT

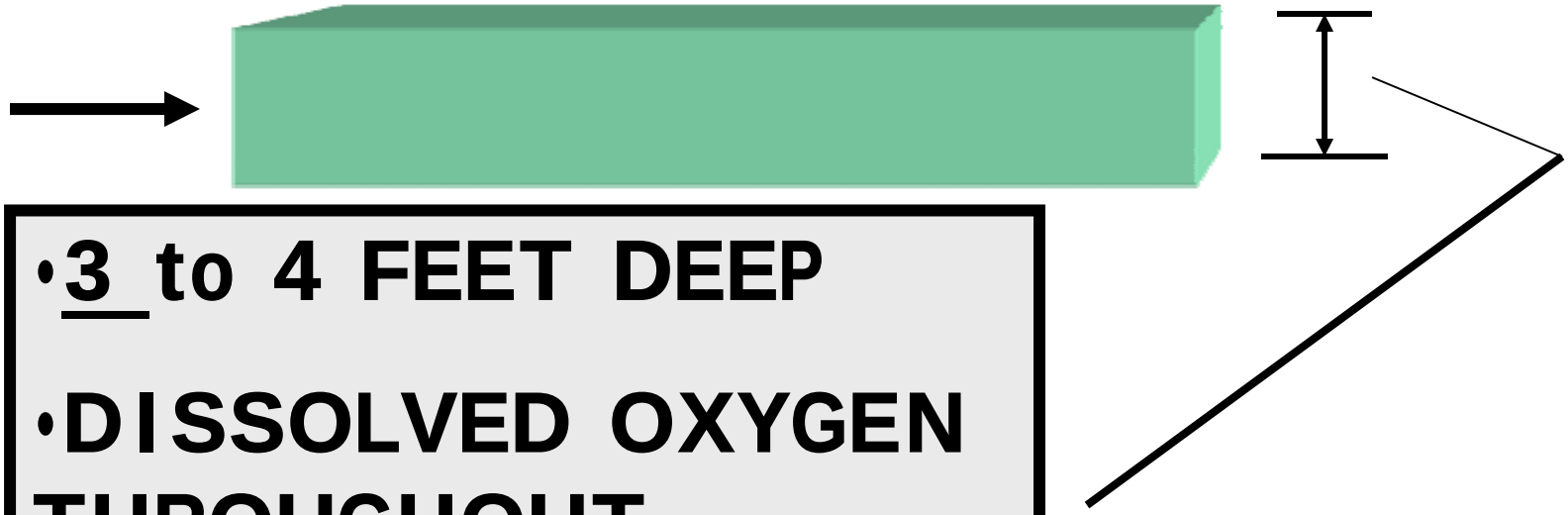
PONDS IN PARALLEL



THREE BASIC TYPES OF PONDS

- AEROBIC
- ANAEROBIC
- FACULTATIVE

AEROBIC PONDS

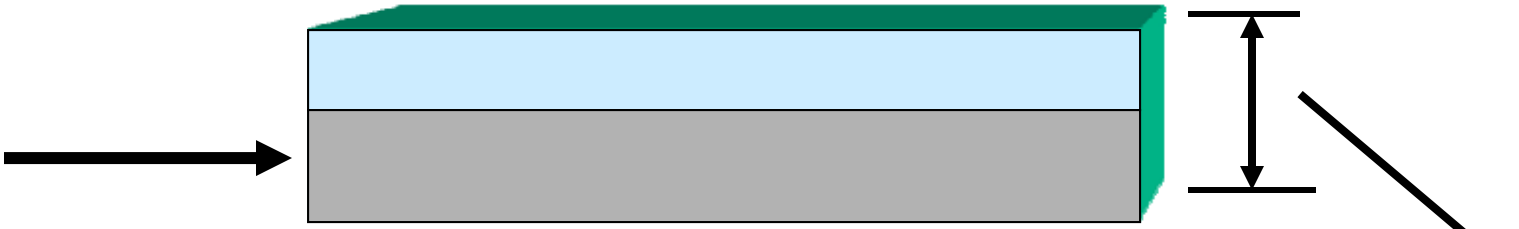


- 3 to 4 FEET DEEP
- DISSOLVED OXYGEN THROUGHOUT
- 30 to 90 DAYS DETENTION TIME

ANAEROBIC PONDS

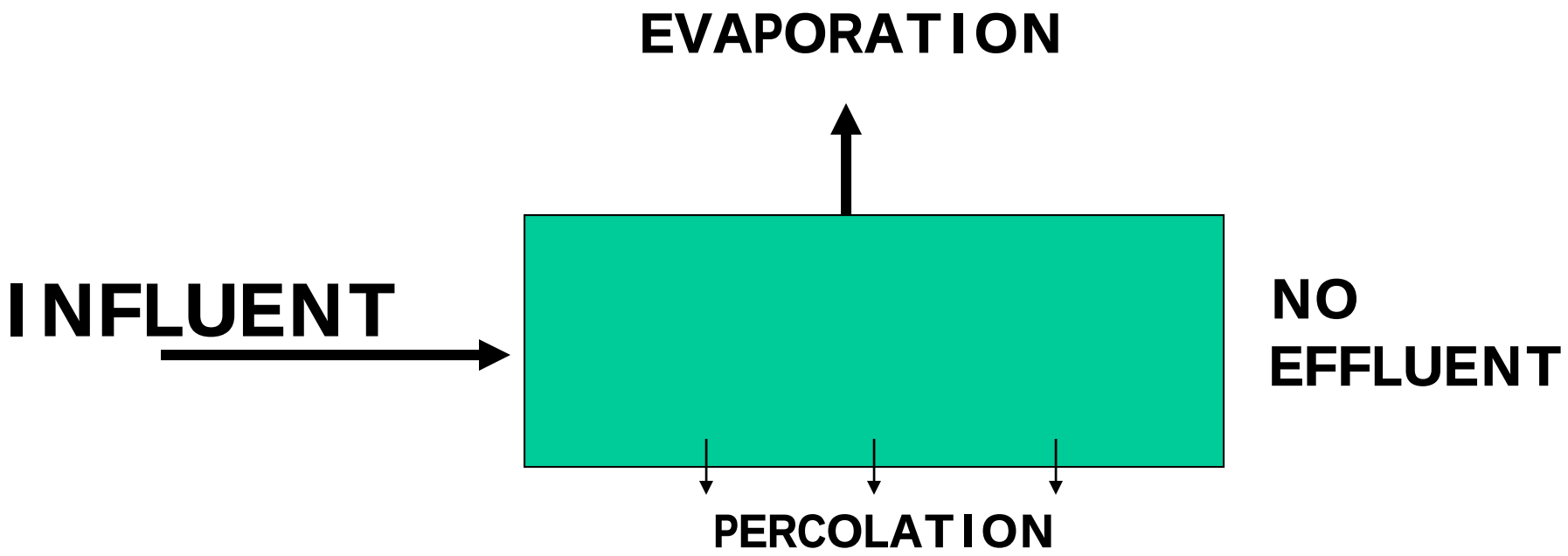
- DEVOID OF OXYGEN
- 6 to 12+ FEET DEEP
- USUALLY INDUSTRIAL WASTE
- DETENTION TIMES VARY (20-? DAYS)

FACULTATIVE POND



- UPPER PART AEROBIC
- BOTTOM ANAEROBIC
  (LIKE A DIGESTER)
- 3 to 6 FEET DEEP
- MOST COMMON TYPE POND

COMPLETE RETENTION LAGOON



INFLUENT = EVAPORATION + PERCOLATION

HOW MANY ACRES OF PONDS (WITH ZERO DISCHARGE) WOULD BE NEEDED TO SERVE 650 PEOPLE IN So. NEW MEXICO?

ASSUME NO PERC & 60"EVAP

650 people X 100 gpd/person / 7.48 gal/cu-ft = 8666 cu-ft/day

8666 cu-ft/[60/365]/12 ft/day = 866,600 sq-ft

866,600 sq-ft/43,560 sq-ft/acre =19.9 acres

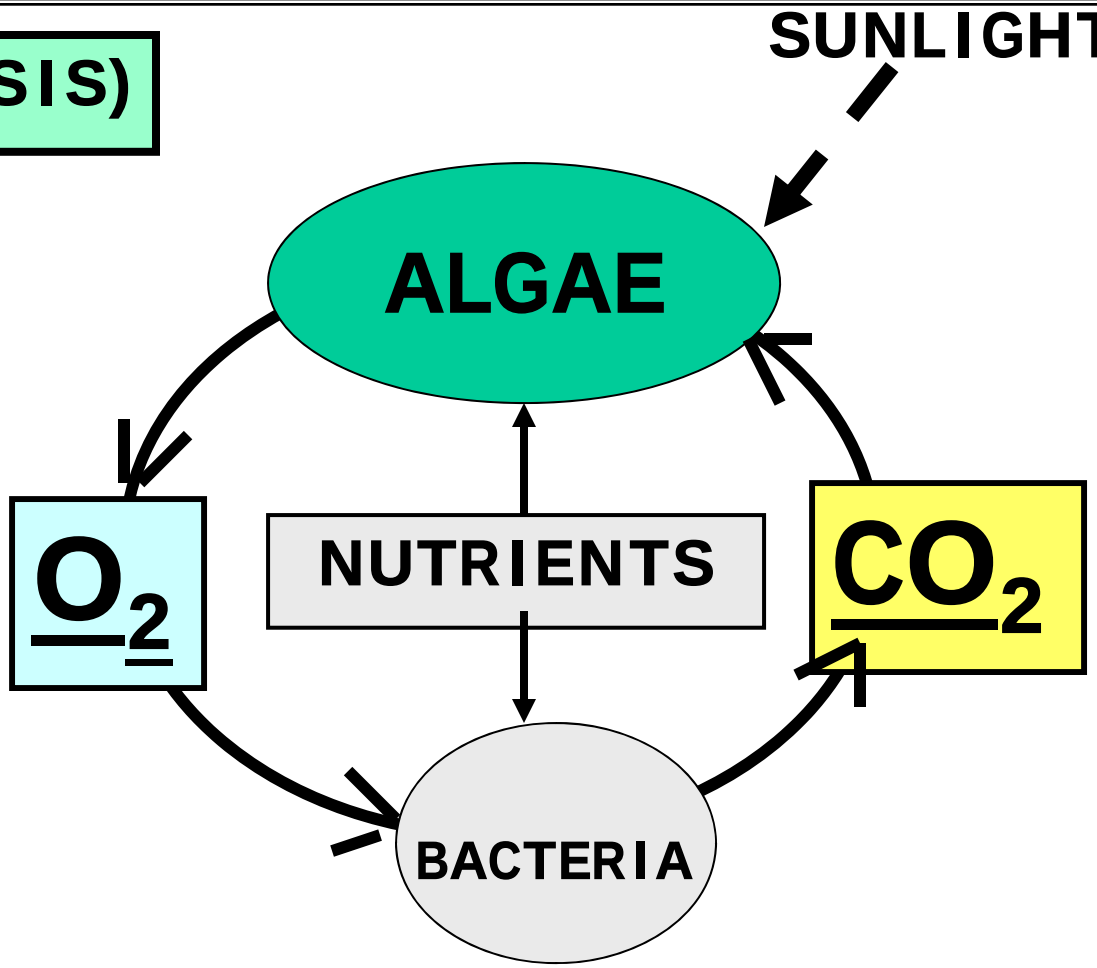
(plus allowances for rain)

ANOTHER IMPORTANT FEATURE OF A WASTE TREATMENT POND IS ITS ABILITY TO EASILY ADJUST TO VARIABLE ORGANIC LOADS

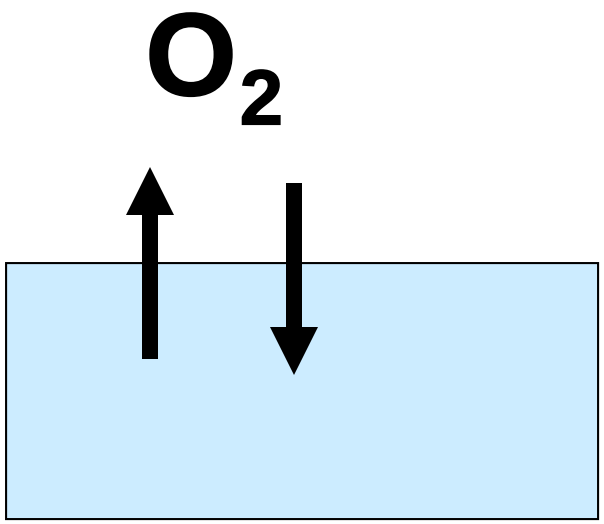
HOW AN AEROBIC POND WORKS

(PHOTOSYNTHESIS)

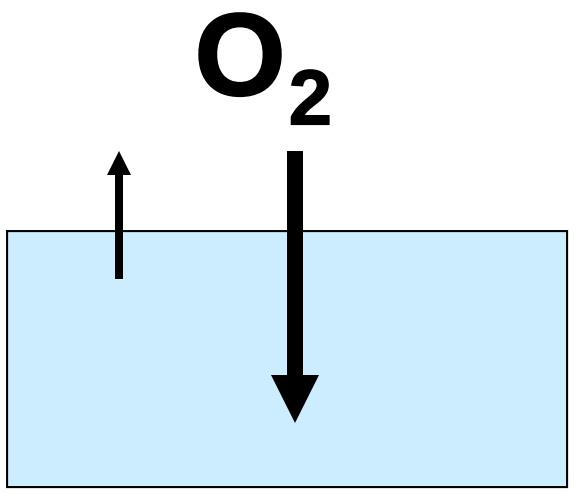
OCCURS WITHIN THE FIRST 2.5 FEET of POND DEPTH



OXYGEN SATURATION



SATURATED



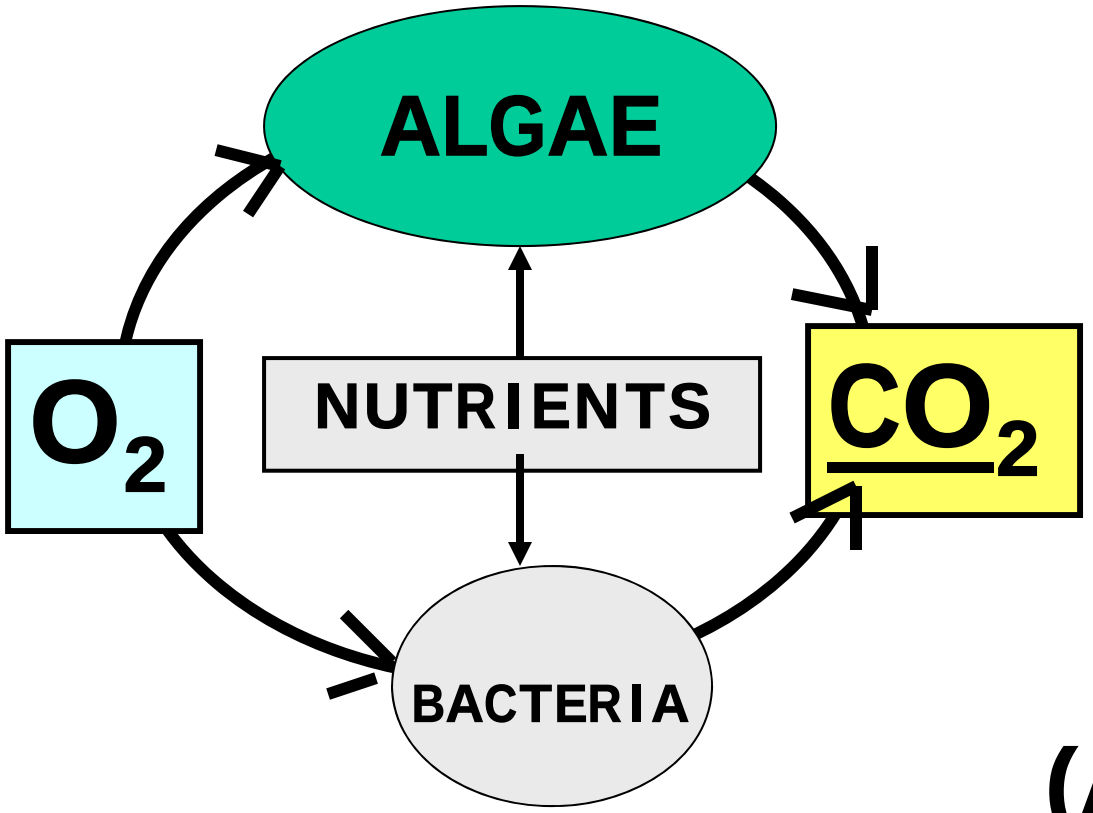
SUPERSATURATED

OXYGEN SATURATION

AT ANY GIVEN TEMPERATURE, WATER CAN HOLD ONLY SO MUCH OXYGEN

TEMPERATURE, °C	mg/L OXYGEN
4	13.1
20	9.1

AT NIGHT-TIME



$+ H_2O =$

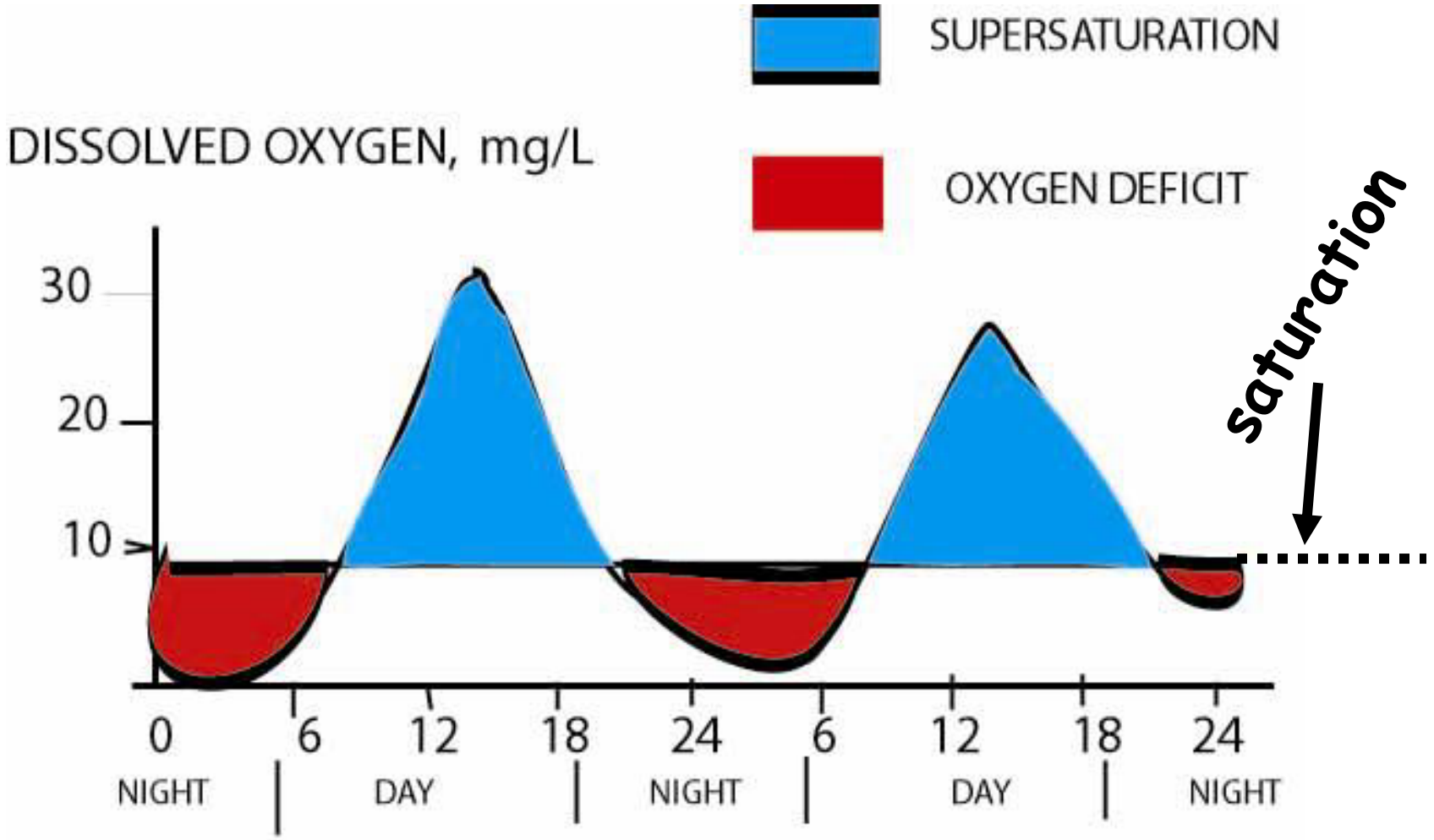
H_2CO_3

(AN ACID) so pH goes down

NEED TO REMEMBER

IN AN AEROBIC OR FACULTATIVE POND:

OXYGEN AND pH go UP DURING THE DAY and DOWN DURING THE NIGHT



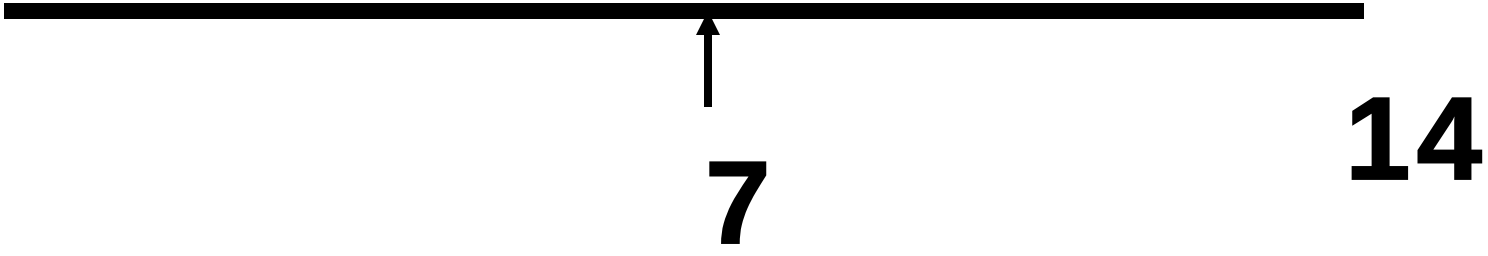
DIURNAL OXYGEN CONC.-LAGOON

pH in a POND

ACIDIC

neutral

BASIC



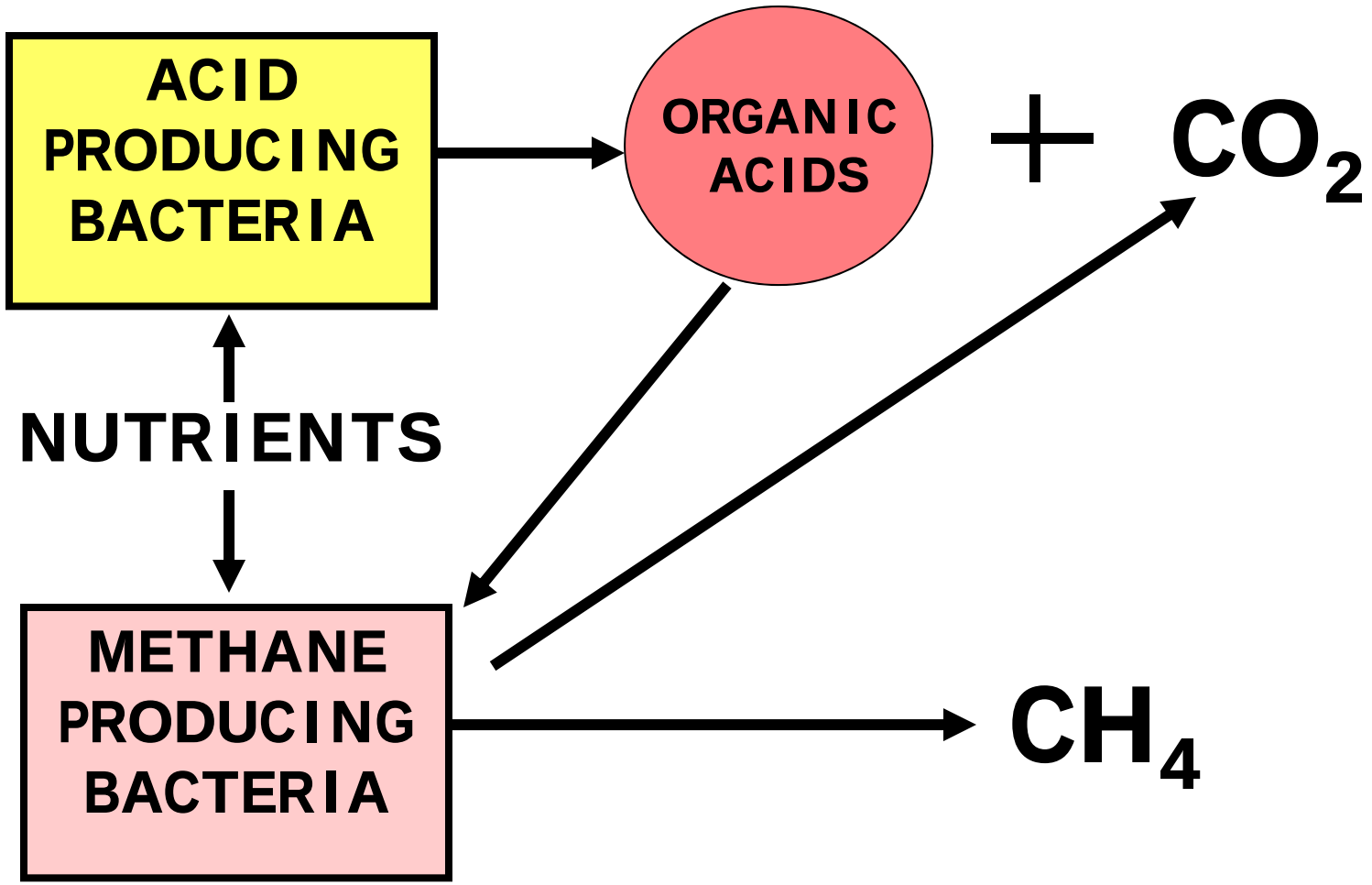
- INFLUENT pH = 6 to 8
- EFFLUENT pH = 9.5 or more

- High pH usually means high dissolved oxygen (pH tied closely to O_2 production)

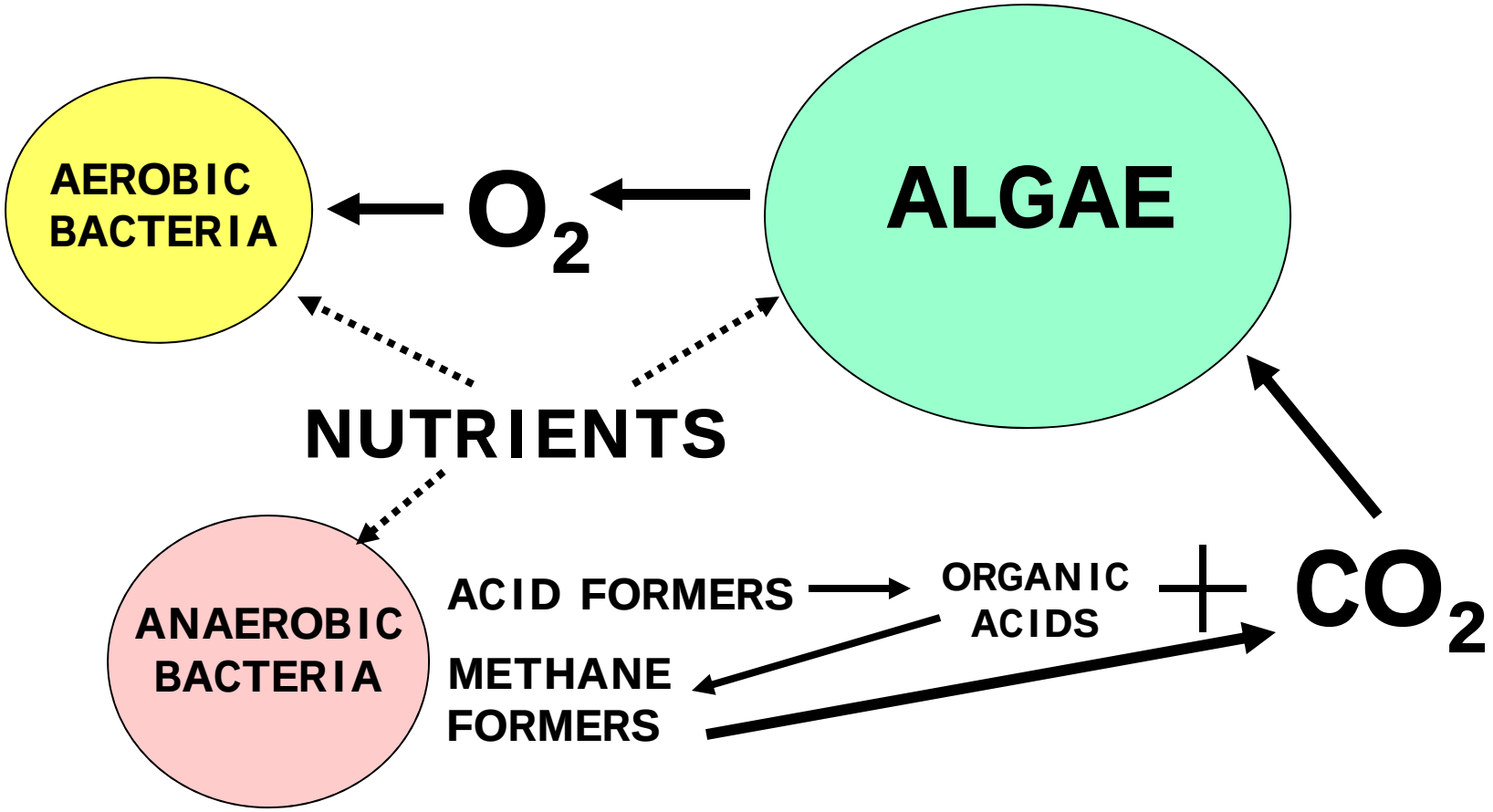
HIGH pH IN POND USUALLY MEANS HIGH DISSOLVED OXYGEN

LOW pH IN POND CAN BE CAUSED BY SEPTIC WASTE AND INDUSTRIAL WASTE

HOW AN ANAEROBIC POND WORKS



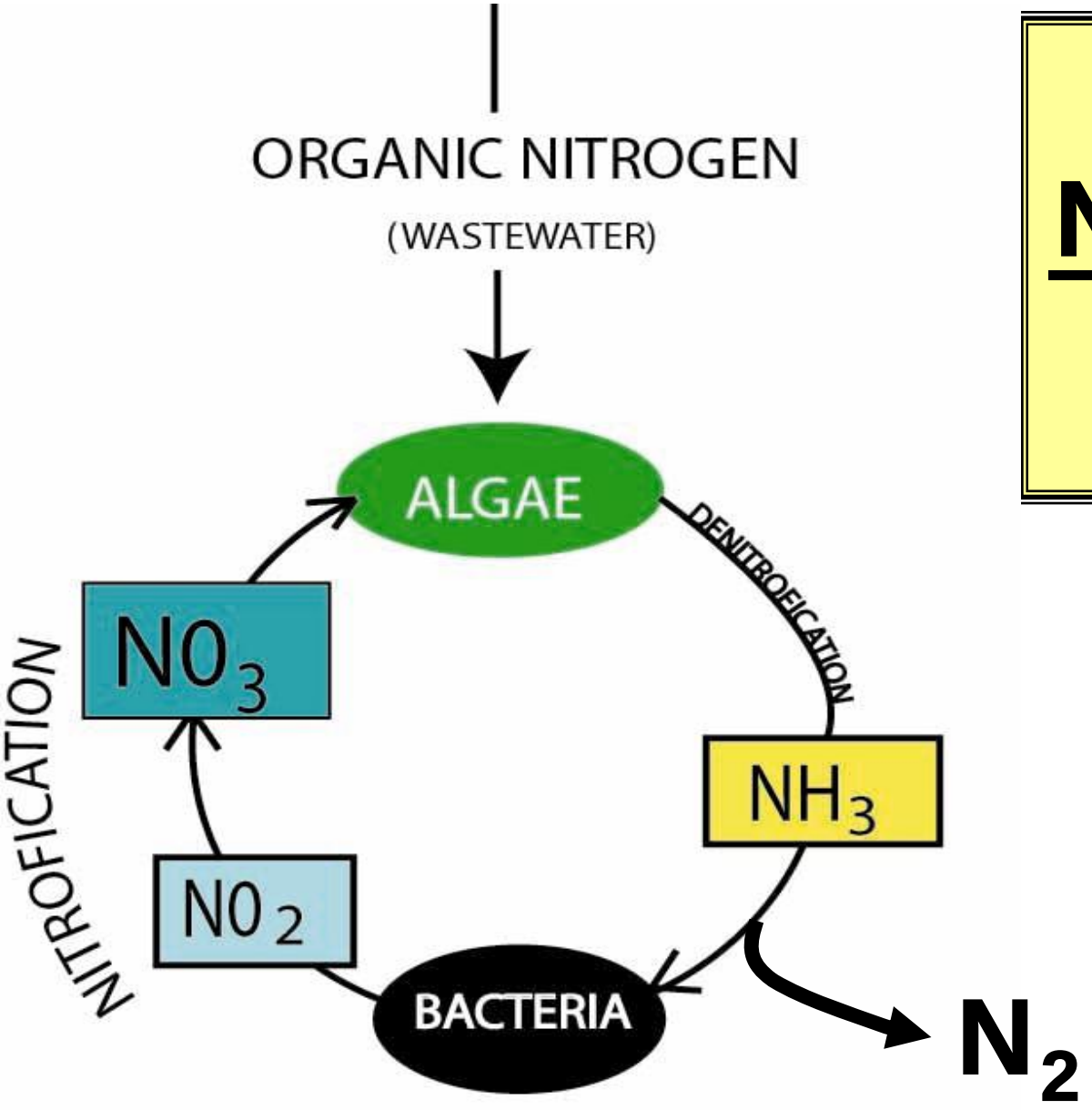
HOW A FACULTATIVE POND WORKS



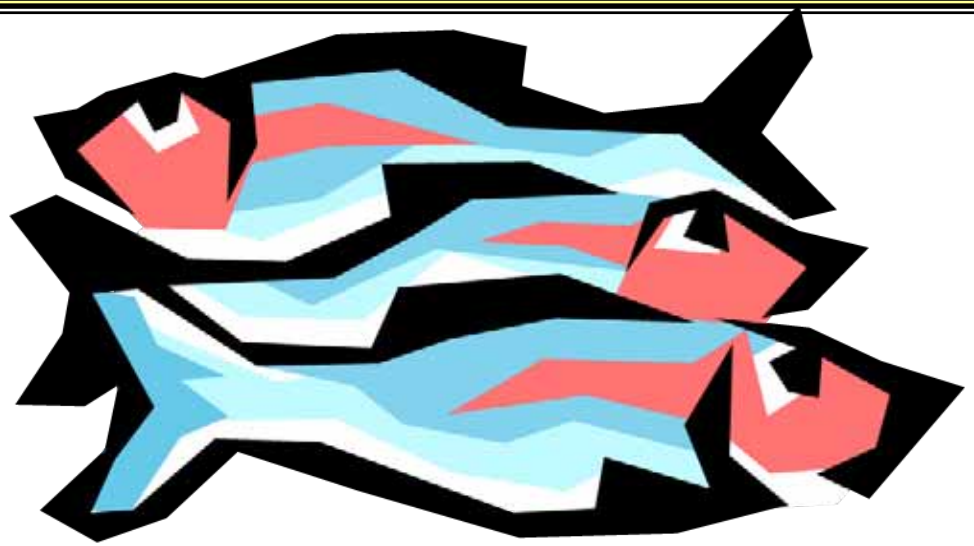
ALGAE AND BACTERIA NUTRIENTS ARE:

NITROGEN (NH_3, NO_3, NO_2) and PHOSPHOROUS (PO_4)

THE NITROGEN CYCLE

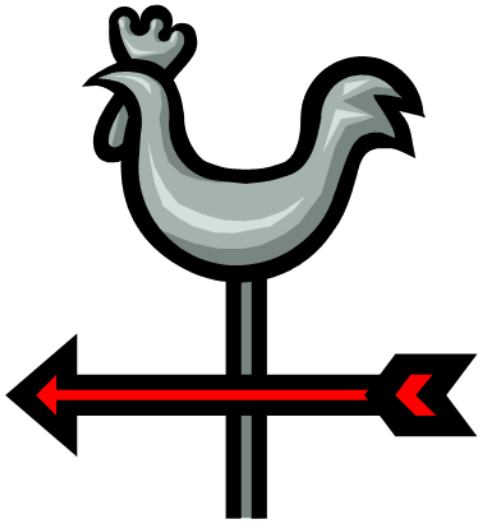


HIGH CONCENTRATIONS OF AMMONIA (NH_3 >20 mg/L) IN THE EFFLUENT CAN BE HARMFUL TO FISH



FACTORS AFFECTING PONDS

-PHYSICAL-

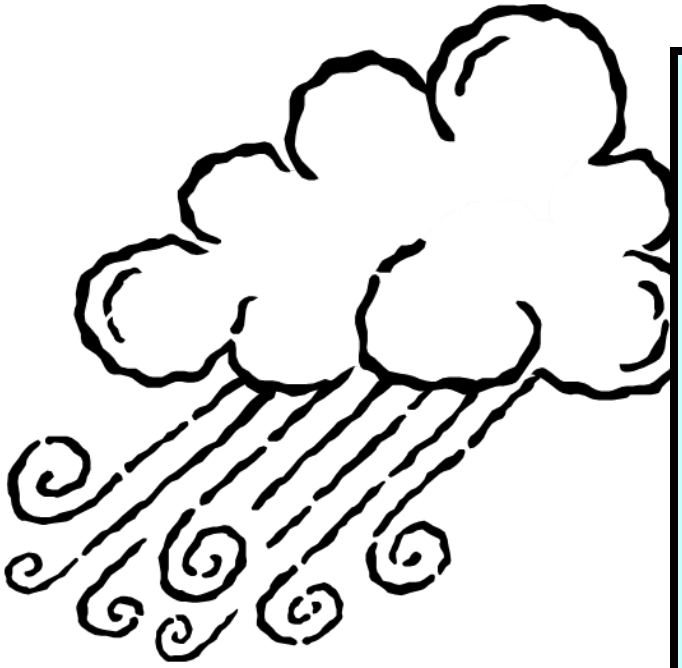


WIND:

- CREATES MIXING
- AFFECTS DISSOLVED OXYGEN

FACTORS AFFECTING PONDS

-PHYSICAL-



TEMPERATURE

- LOW WATER TEMP HOLDS MORE OXYGEN
- HIGH WATER TEMP INCREASES MICROBIAL ACTIVITY

FACTORS AFFECTING PONDS

-PHYSICAL-

SUNLIGHT

- ESSENTIAL FOR ALGAE GROWTH

SHORT-CIRCUITING

FACTORS AFFECTING PONDS

-CHEMICAL-

- ORGANIC MATERIAL
- pH
- TYPE OF SOLIDS

FACTORS AFFECTING PONDS

-BIOLOGICAL-

- TYPE(S) OF ALGAE
- ACTIVITY OF ORGANISMS
- NUTRIENTS AVAILABLE
- TOXICANTS

PREDOMINATE TYPES OF ALGAE

- GREEN
- BROWN
- RED
- CYANOBACTERIA (BLUE-GREEN)

TERM TO REMEMBER!!

BIOFLOCCULATION

THE "CLUMPING" TOGETHER OF ALGAE AND BACTERIA WHICH SETTLES AND REMOVES SUSPENDED AND DISSOLVED SOLIDS

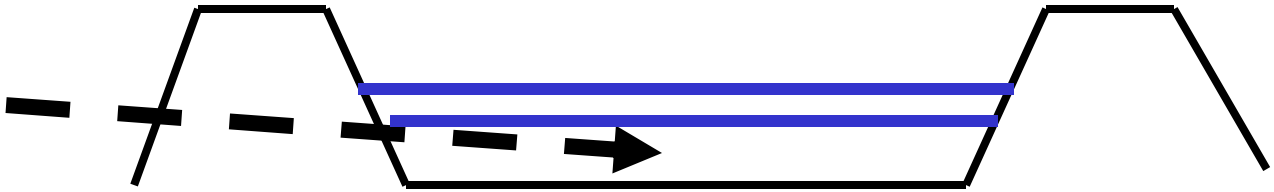
POND PERFORMANCE

REMOVAL EFFICIENCIES

BOD/SS 90 – 95%

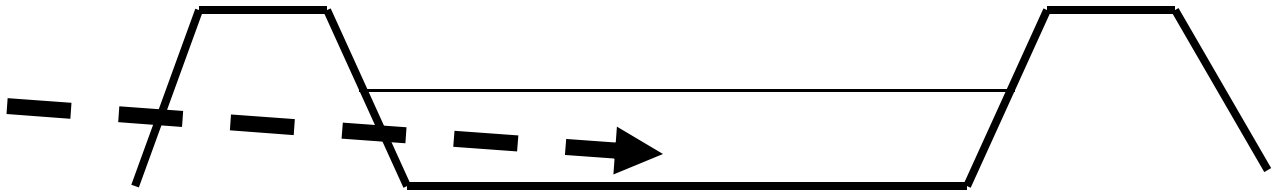
FECAL COLIFORM 99%

POND START-UP



ADD 1 to 2 FEET OF WATER TO THE POND BEFORE ANY WASTEWATER TO PREVENT ODORS AND TO HELP THE POND GET STARTED. ALSO KEEP pH >7.5 (ADD SODA ASH)

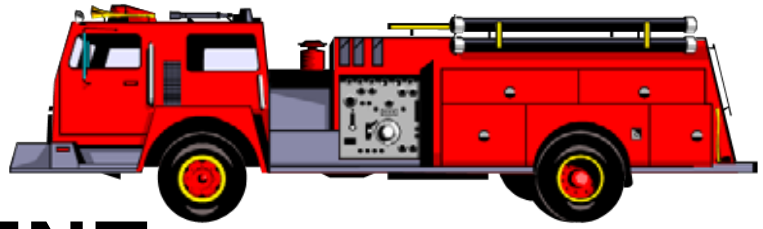
POND START-UP



ALSO, THIS WATER HELPS TO CONSERVE _____ AND GIVES THE BIOLOGICAL ACTIVITY A BETTER START

OPERATION & MAINTENANCE

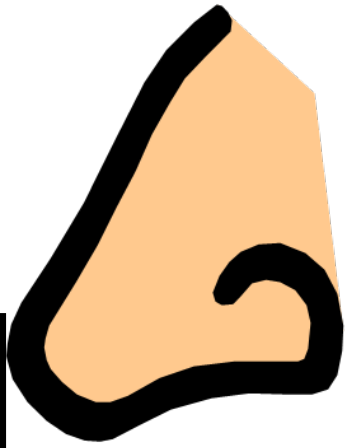
SCUM CONTROL



TO PREVENT CRUSTING (LOSS OF SUNLIGHT) AND TO DESTROY A HABITAT FOR PATHOGENS AND VECTORS

OPERATION & MAINTENANCE

ODOR CONTROL



- USUALLY CAUSED BY OVERLOADING OR POOR MAINTENANCE

- SOMETIMES A PROBLEM IN SPRINGTIME—MIGHT HAVE TO AERATE OR ADD SODIUM NITRATE

OPERATION & MAINTENANCE

IF HYDROGEN SULFIDE (H_2S) ODOR IS PRESENT, RAISING THE pH ABOVE 8.5 (THE pH OF A NORMALLY OPERATED POND) WILL LIKELY TAKE CARE OF THE PROBLEM

OPERATION & MAINTENANCE

WEED & INSECT CONTROL

PROBLEM: ALTERS WIND MOVEMENT AND PROVIDES A VECTOR HABITAT

- **KEEP >3 ft of WATER TO PREVENT CATTAIL & TULE GROWTH (LIMITS SUNLIGHT)**

CATTAILS

OPERATION & MAINTENANCE

WEED & INSECT CONTROL

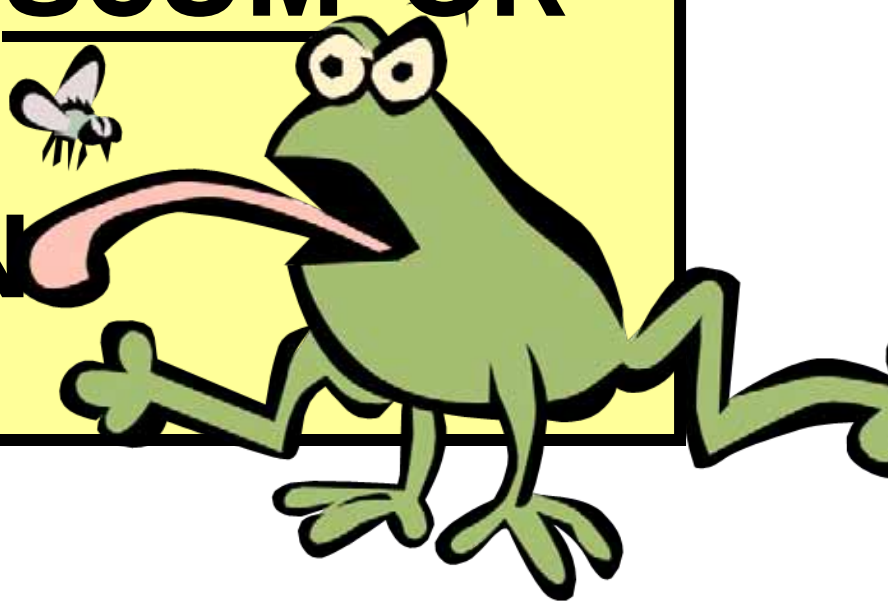
PROBLEM: ALTERS WIND MOVEMENT AND PROVIDES A VECTOR HABITAT

- **KEEP >3 ft of WATER TO PREVENT CATTAIL & TULE GROWTH (LIMITS SUNLIGHT)**

- **REMOVE EMERGENT GROWTH BY HAND – USE HERBICIDES AS LAST RESORT**

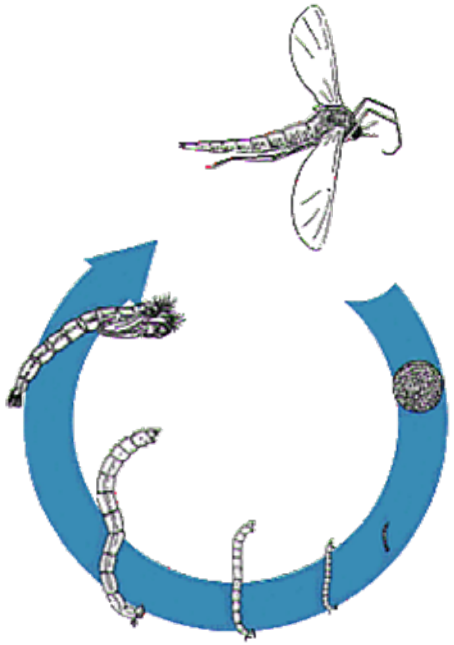
MOSQUITOES CAN BE A PROBLEM

EGG RAFTS CAN ATTACH TO SCUM OR EMERGENT VEGETATION



MOSQUITOES SOMETIMES CONTROLLED BY…

GAMBUSIA (MOSQUITO FISH)



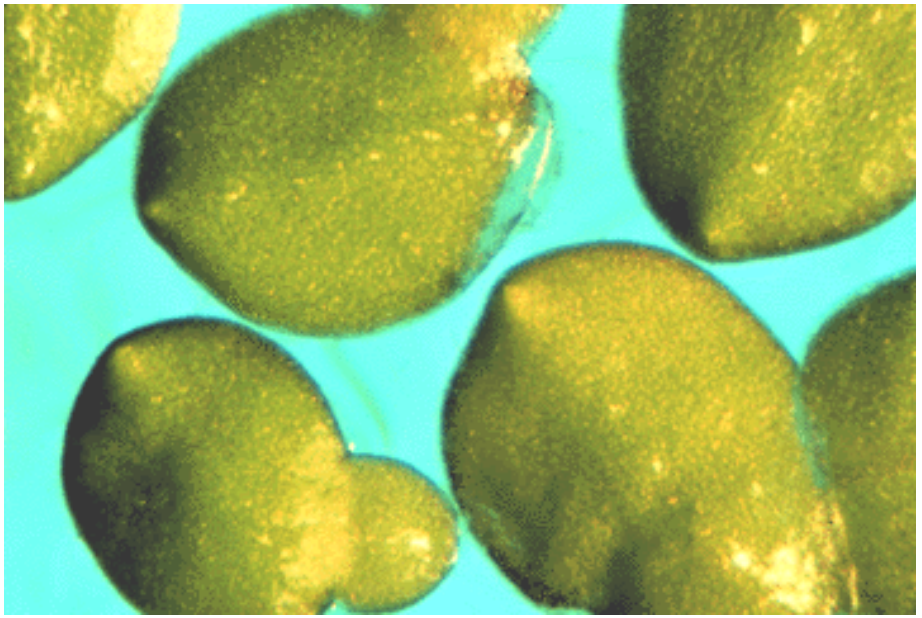
CHIRONOMID MIDGE

(chir-AHN-ah-mid)

2 CHOICES: LIVE WITH THEM or USE A PESTICIDE

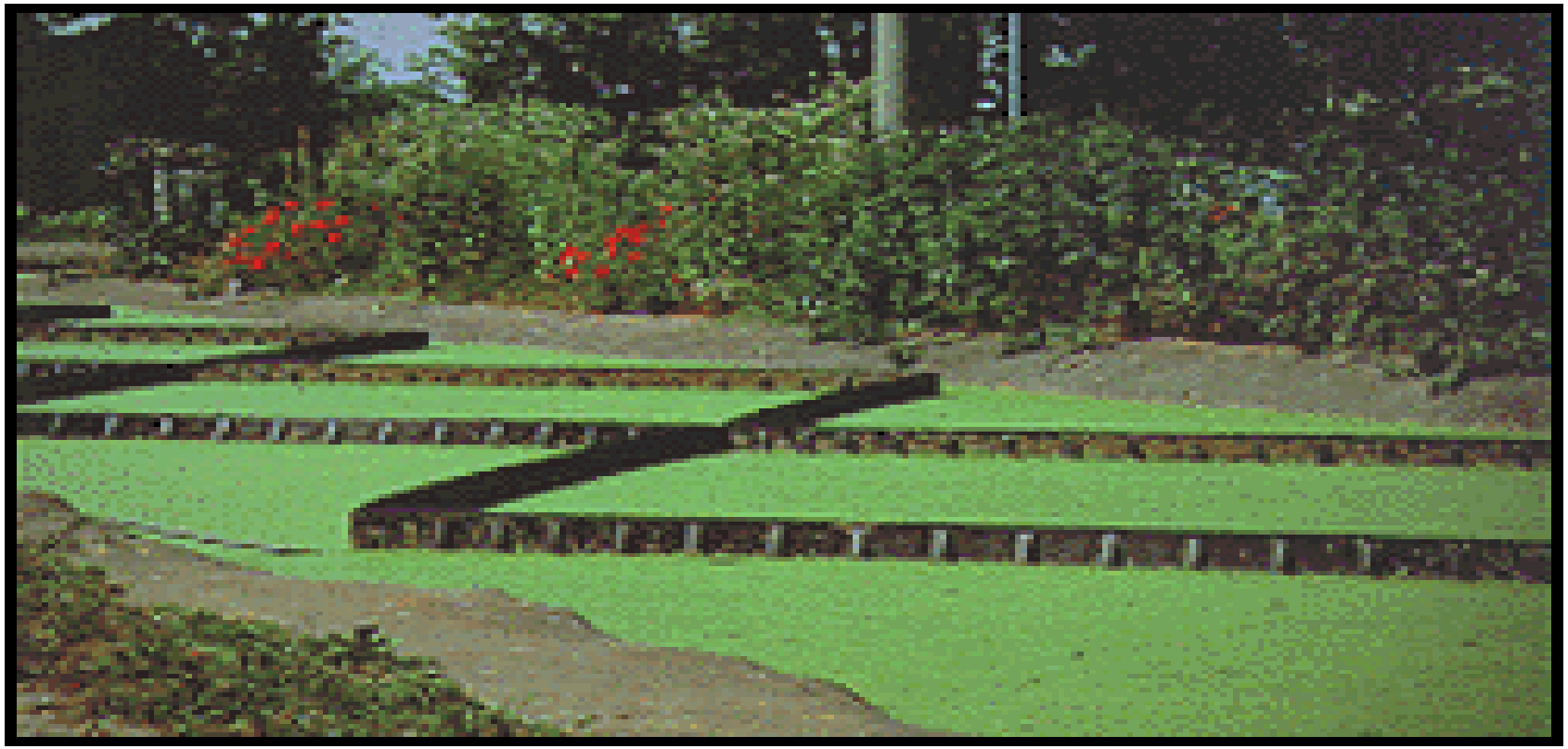
OPERATION & MAINTENANCE

DUCKWEED



DUCKWEED CAN BLOCK SUNLIGHT AND HARBOR VECTORS & TOXINS

BOTULISM IN SCUM CAN BE DEADLY TO WATERFOWL!

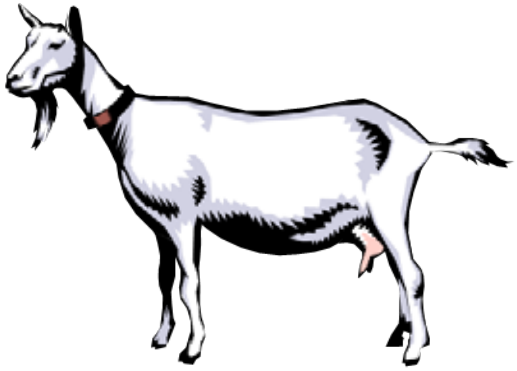


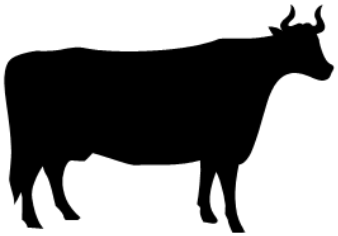
- DUCKWEED CAN BE CONTROLLED WITH GOOD WIND CIRCULATION

USE PESTICIDES AS A LAST RESORT

OPERATION & MAINTENANCE

DIKE / LEVEE VEGETATION





MOW REGULARLY and CONTROL BURROWING ANIMALS

DO NOT ALLOW ANIMALS TO GRAZE!

SAMPLING AND ANALYSES

- FOR POND CONDITION: pH and dissolved oxygen - - 5/week (night?)

- TEMPERATURE, pH, DISSOLVED OXYGEN & CHLORINE RESIDUAL—SHOULD BE ANALYZED IMMEDIATELY (GRAB SAMPLE)

DISSOLVED OXYGEN (D.O.)

- GOOD INDICATOR OF ACTIVITY (IN AEROBIC POND)

- BY WATCHING D.O., OVERLOADING CAN BE DETERMINED

- LOW D.O. = HIGH BOD

SAMPLING AND ANALYSES

***FOR TREATMENT EFFICIENCY*:**

- **BOD, SUSPENDED SOLIDS, (COMPOSITE SAMPLES)**

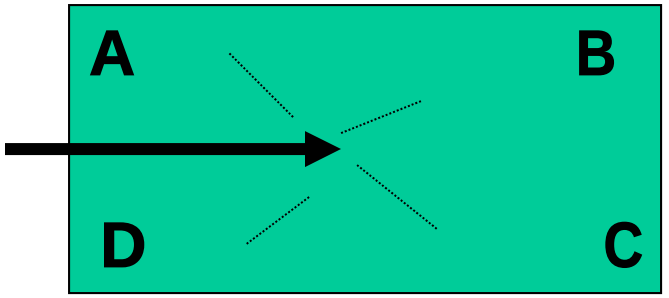
- **COMPOSITE SAMPLES SHOULD BE <u>PRECISE</u>**

COMPOSITE SAMPLES

2 TYPES OF COMPOSITES; WITH RESPECT TO…

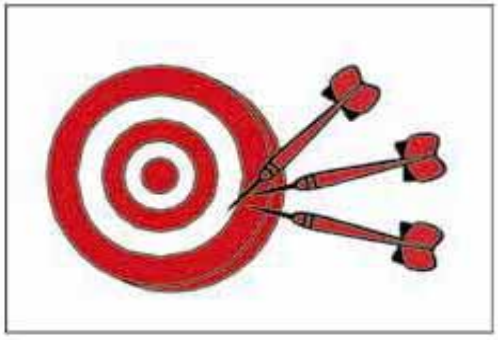
A. TIME & FLOW

B. LOCATION

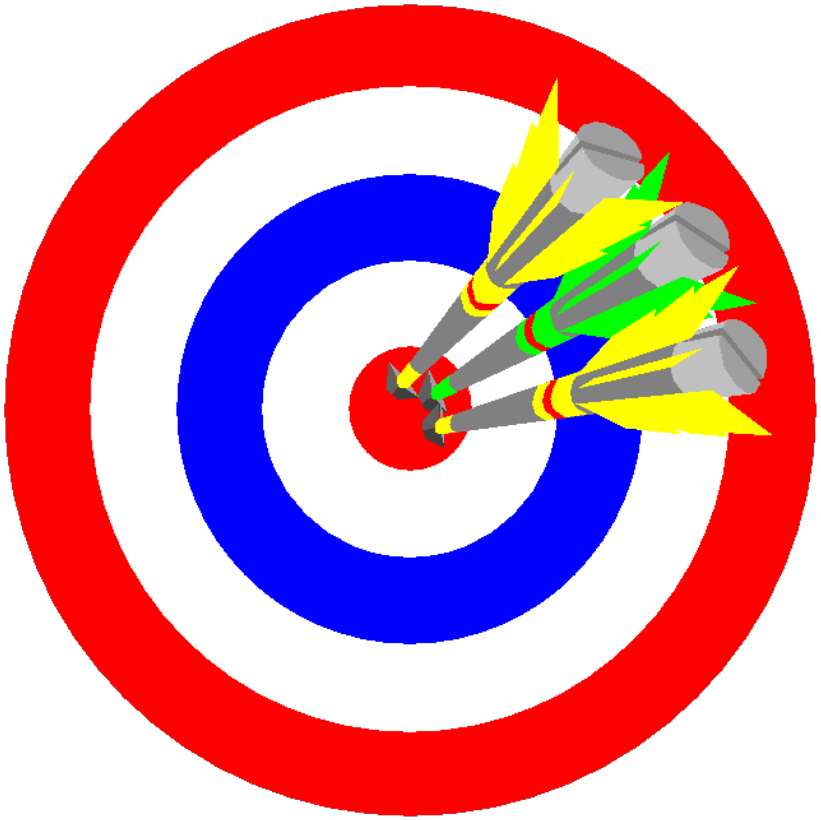


ACCURACY vs PRECISION

ACCURACY



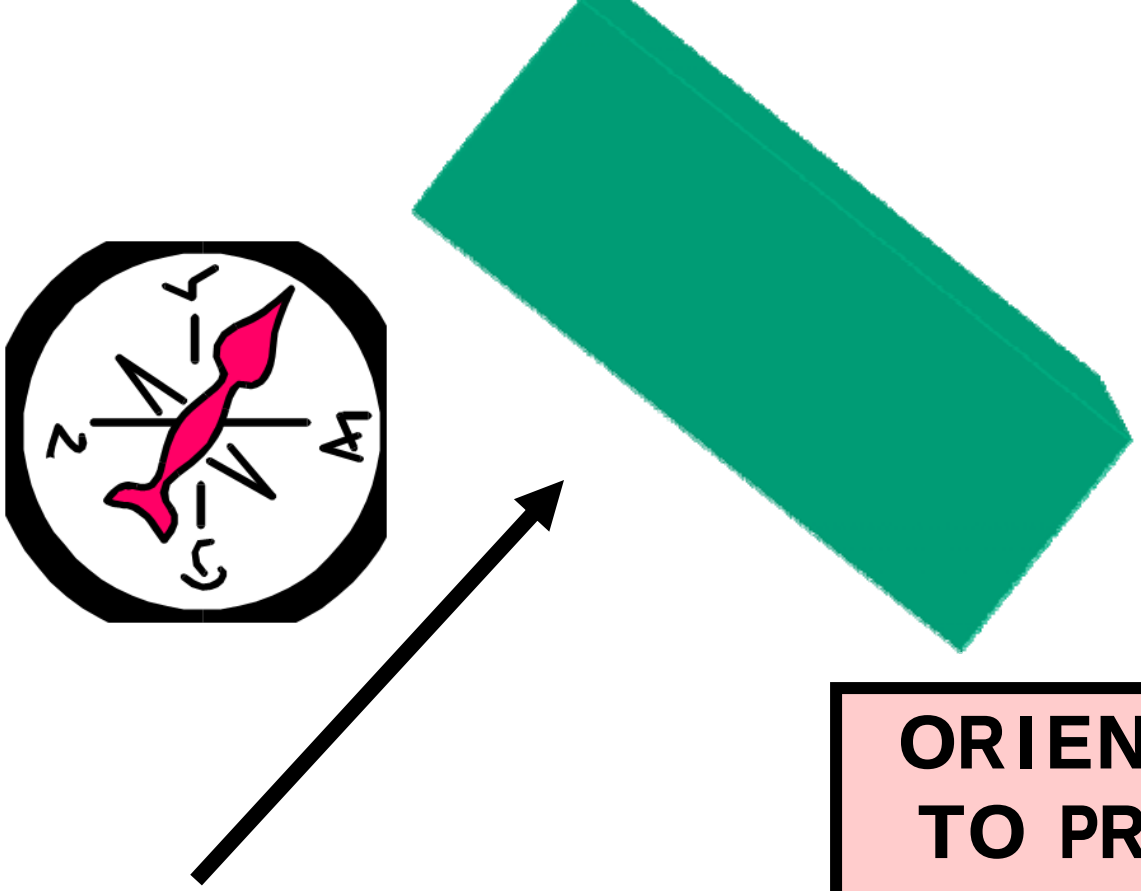
PRECISION



ACCURATE & PRECISE

LOCATION AND PROTECTION OF PONDS

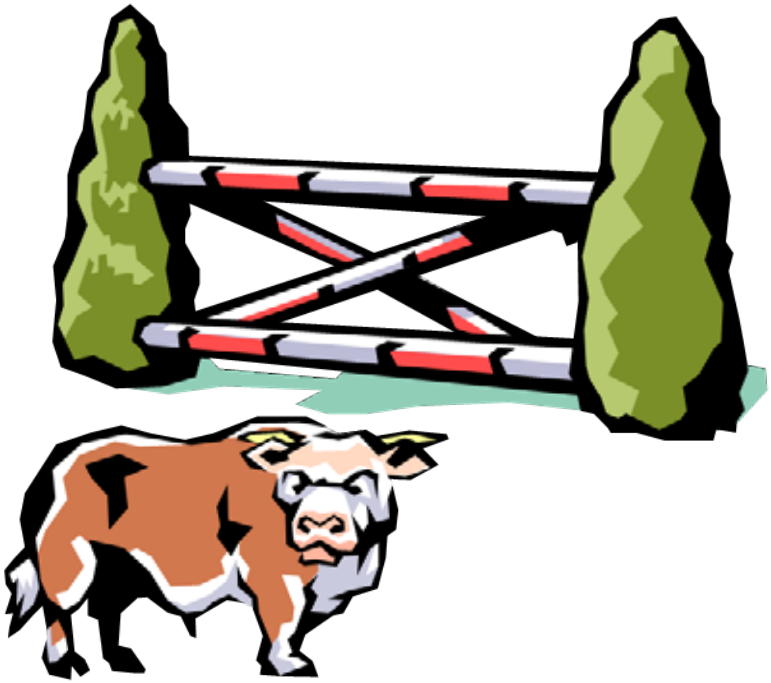
- SAME AS ANY WWTP: DOWN-GRADIENT (if possible)
- ORIENTED WITH RESPECT TO THE WIND



PREVAILING WIND

ORIENT THE POND TO PREVENT DIKE EROSION BUT TO MAXIMIZE SCUM DISPERSION AND RE-AERATION

PONDS SHOULD BE FENCED TO KEEP OUT LIVESTOCK AND TO DISCOURAGE TRESPASSERS



WASTEWATER TREATMENT PLANT

NO TRESPASSING

POND LOADING

- **ORGANIC LOADING:**

  LBS BOD/DAY/ACRE

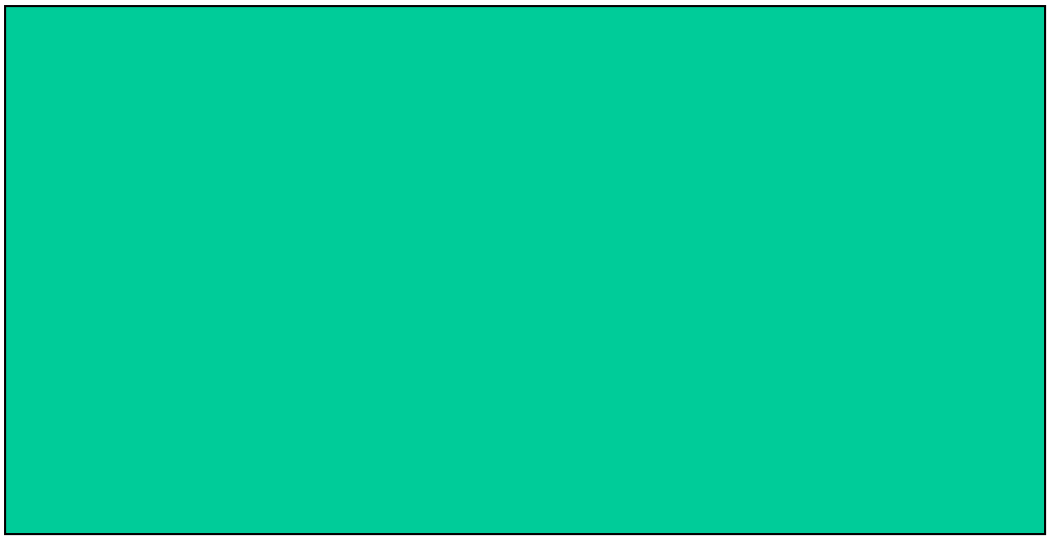
- **HYDRAULIC LOADING:**

  INCHES/DAY

- **POPULATION LOADING:**

  PERSON/ACRE

ARITHMETIC REVIEW



SURFACE AREA = L x W

1 ACRE = 43,560 SQ-FT

REMEMBER….

EACH PERSON DISCHARGES 75-100 GALLONS of WASTEWATER PER DAY

0.2 POUNDS BOD/PERSON

CALCULATING BOD LOADING

CONCENTRATION,ppm X FLOW,MGD X 8.34 lbs/gal = POUNDS/DAY

What is the daily BOD loading, in pounds given the following:
FLOW=300,000 gal/day;
BOD = 225 mg/L?

BOD LOADING =

225 ppm X 0.3 MGD X 8.34 =

563 lbs/day

AT AN ALLOWABLE LOADING OF

35 lbs-BOD per day/acre, how large of a pond is necessary?

$$\frac{563\ \#/day}{35\ \#/day/acre} = 16\ acres$$

DETENTION TIME:

$$\frac{\text{POND VOLUME, acre-ft}}{\text{INFLUENT RATE, acre-ft/day}}$$

ORGANIC LOADING:

$$\frac{\text{(BOD mg/L) (FLOW, MGD) (8.34 \#/gal)}}{\text{POND AREA, acres}}$$

SURFACE LOADING RATE

TYPE	lbs BOD/acre/day
AEROBIC	60 - 200
ANAEROBIC	200 - 1000
FACULTATIVE	15 - 30
TERTIARY	5 - 15
MECH. AERATED	20 - 400

COMMON PROBLEMS

PROBLEM	CAUSE (?)
ODOR	• BOD OVERLOAD • POOR AERATION/ MIXING • ICE MELTED

ODOR CONTROL

- REDUCE BOD LOAD BY TAKING POND OFF-LINE AND GRADUALLY RE-LOADING THE UNIT

- RECIRCULATE FROM AN AEROBIC POND (about 17%) TO RESTORE OXYGEN IN "SICK" POND

- USE MECHANICAL AERATOR or ADD SODIUM NITRATE

COMMON PROBLEMS

PROBLEM	CAUSE (?)
POOR BOD REMOVAL	• OVERLOADED • SHORT-CURCITING • SNOW/ICE COVER • RECENT TEMP DROP • ALGAL BLOOM

COMMON PROBLEMS

PROBLEM	CAUSE (?)
HIGH SUSPENDED SOLIDS IN EFFLUENT	• ALGAL BLOOM • TOO MUCH MIXING/SHORT-CIRCUITING • SEASONAL OVERTURN

ALGAE BLOOM

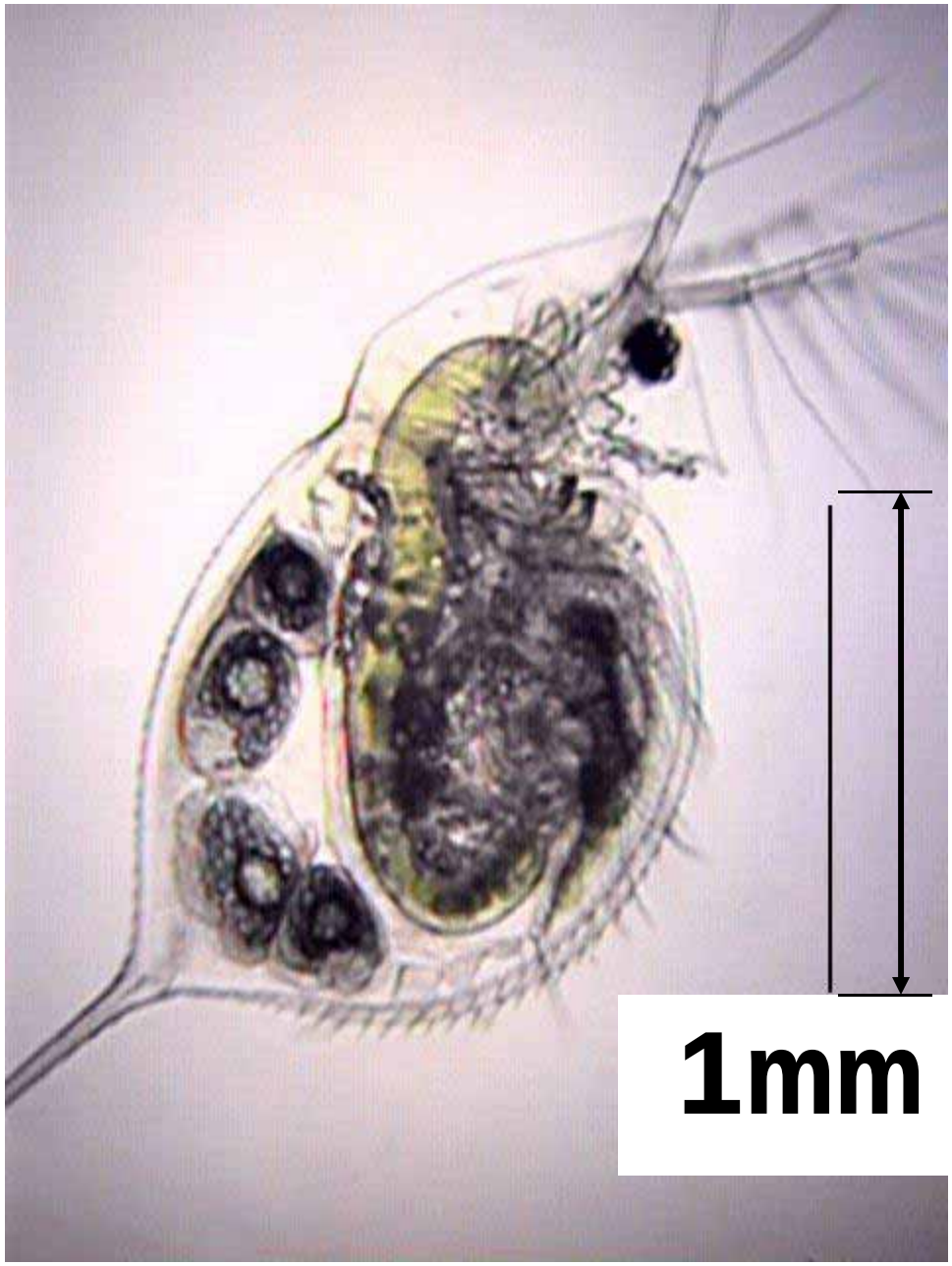
CAUSE <u>ODORS</u> and CAN BE TOXIC

PREDOMINATE TYPES OF ALGAE

- GREEN
- BROWN
- RED
- CYANOBACTERIA (BLUE-GREEN)

ALGAL CONTROL MEASURES

- FILTER the EFFLUENT
- CENTRIFUGE the EFFLUENT
- COPPER SULFATE ($CuSO_4$)
- WATER HYACINTH
- ALGAE "EATERS"- - DAPHNIA



DAPHNIA

AKA WATER FLEAS

WILL FEED ON ALGAE

COMMON PROBLEMS

PROBLEM	CAUSE (?)
POOR FECAL COLIFORM REMOVAL	•POOR DISINFECTION •INCREASE IN CHLORINE DEMAND IN THE EFFLUENT

COMMON PROBLEMS

PROBLEM	CAUSE (?)
HIGH pH	• ALGAL BLOOM
LOW pH	• SLUDGE ACCUMULATION • EXCESSIVE NITRIFICATION ($NH_3 \longrightarrow NO_3$)

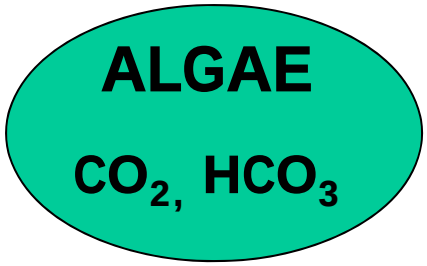
VISUAL INDICATORS

pH	COLOR
>9	GREEN
<7	YELLOW-GREEN

pH is lower in the morning (CO_2 produced by bacteria @ night)

pH is higher in the afternoon

pH AS A DISINFECTANT?



HCO_3 DRIVES UP THE pH to >9.5 which kills pathogens

LEVEE CONTROL

- IF ERODING, PROTECT WITH RIP-RAP or SEMI-POROUS PLASTIC MEMBRANE

RIP RAP ALSO KEEPS THE VEGETATION GROWTH DOWN

O&M GOAL FOR PONDS

- DEEP GREEN COLOR (high pH & DO)
- MEET NPDES DISCHARGE LIMITS
- NO EMERGENT VEGETATION IN THE WATER; NO TALL WEEDS ON THE BANK
- EROSION CONTROL ON DIKES

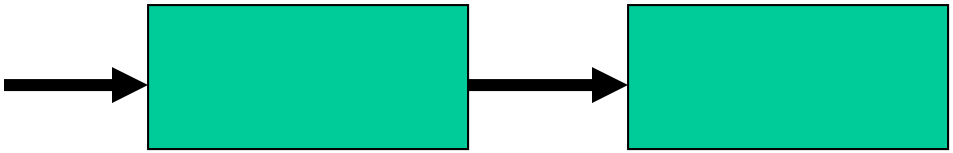
O&M GOAL FOR PONDS

- CLEAN INLET/OUTLET STRUCTURES

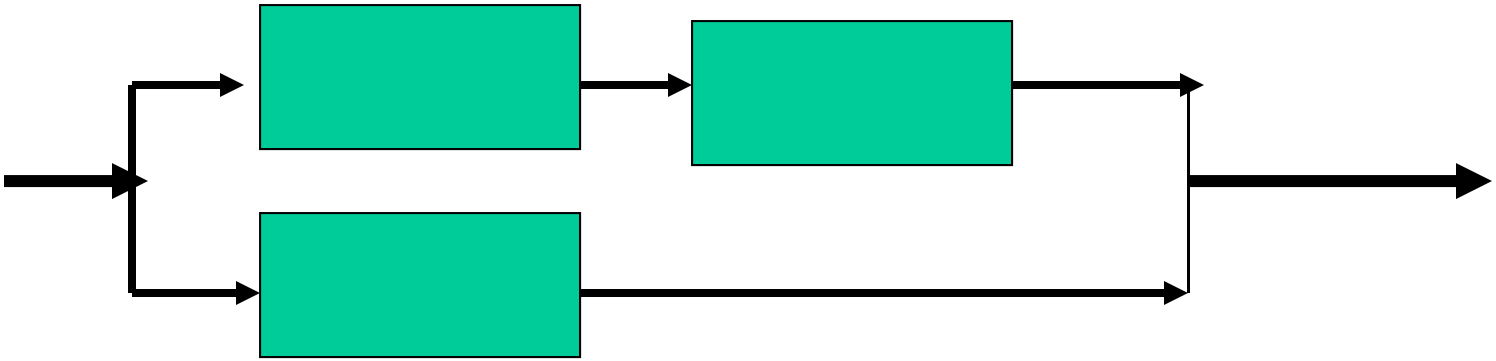
- MECHANICAL EQUIPMENT IS WELL MAINTAINED

- NEAT & COMPLETE RECORDS ON PLANT OPERATION and MAINTENANCE

SERIES AND PARALLEL OPERATION

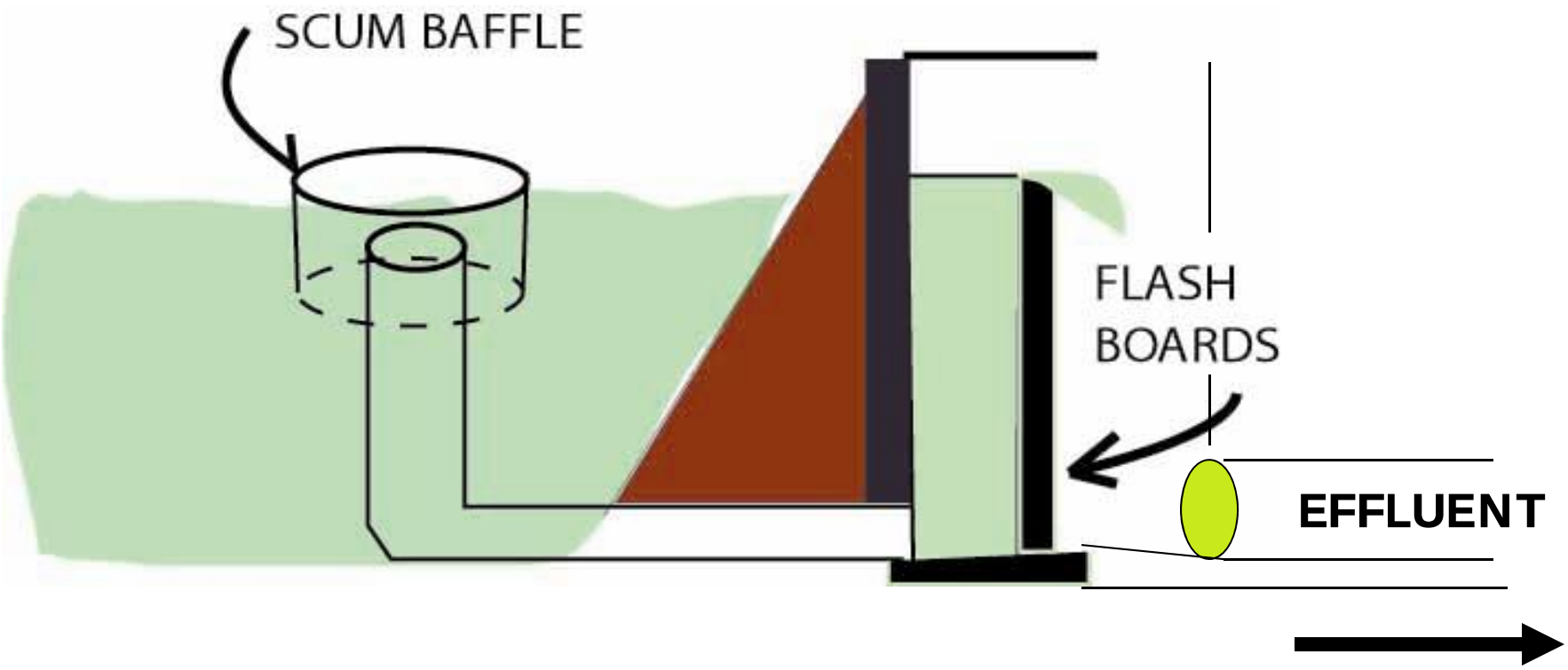


2 PONDS ARE NORMALLY RUN IN SERIES



FOR 3 OR MORE, 1st TWO IN PARALLEL

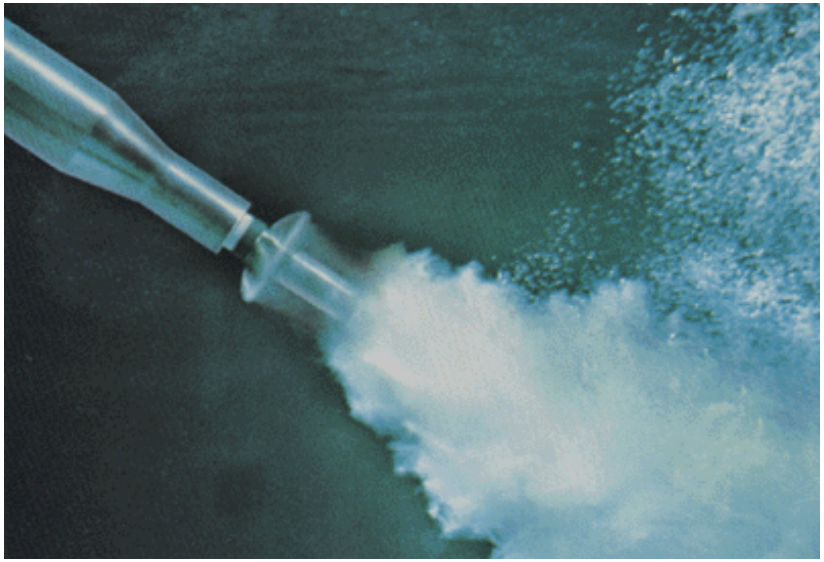
POND OUTLET STRUCTURE



MECHANICALLY AERATED PONDS (BEHAVE LIKE AN ACTIVATED SLUDGE PLANT)

AERATORS

DIFFUSED-AIR



AERATORS

SURFACE MOUNTED

MECHANICALLY AERATED PONDS

- PROVIDES ADDITIONAL AIR (NIGHT, WINTER, WHEN OVERLOADED)

- CREATES AN "ACTIVATED SLUDGE-LIKE" PROCESS

AERATOR MAINTENANCE

- MAKE SURE AERATOR IS TURNED OFF AND LOCKED-OUT

CLEANING DIFFUSORS, REMOVING DEPOSITS, KILLING SLIME (see text):

- HYDROGEN CHLORIDE GAS (DANGEROUS)
- HIGH PRESSURE AIR PURGING