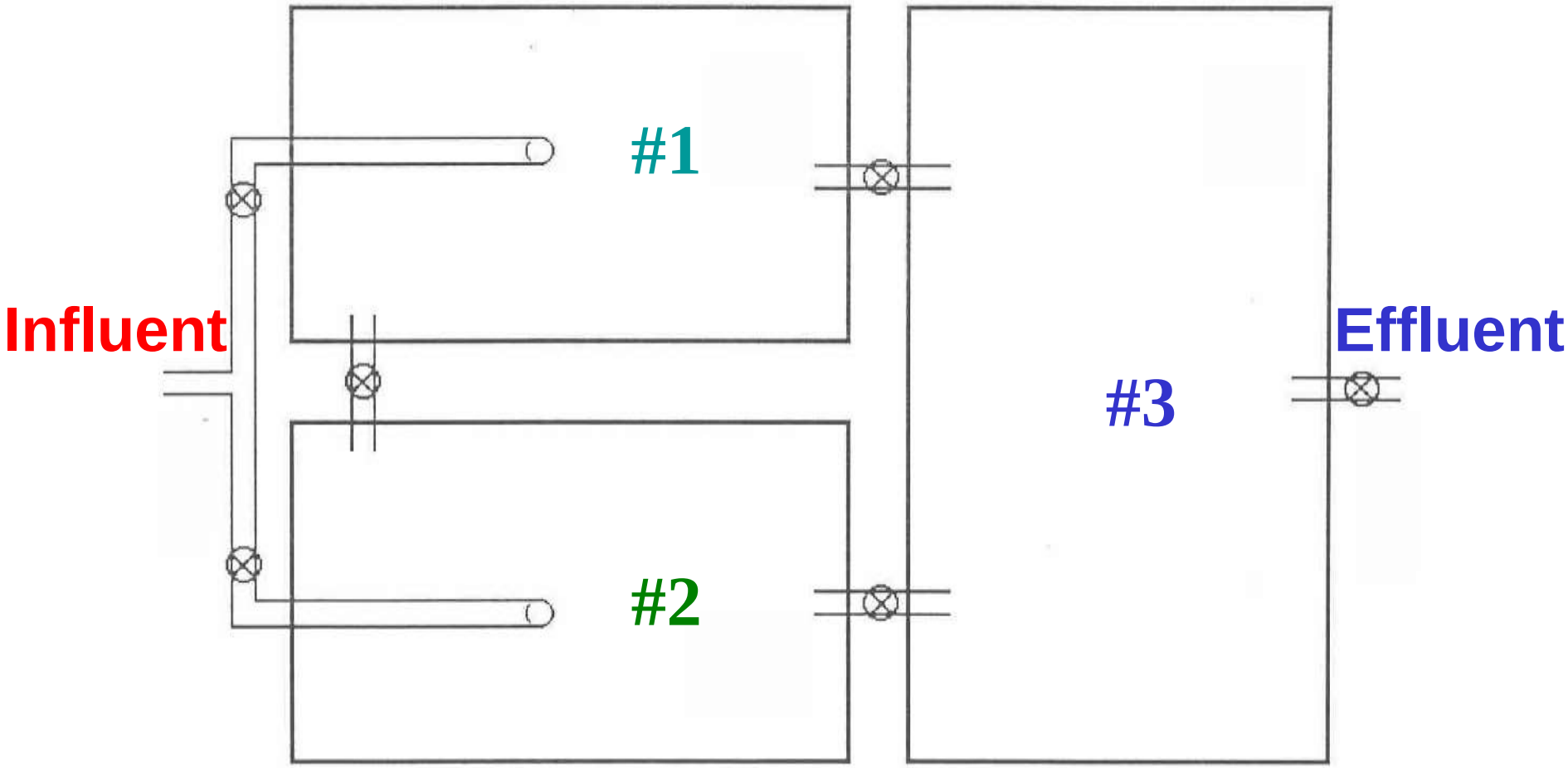
WASTEWATER STABILIZATION LAGOON PROCESS

Prepared by
Michigan Department of Environmental Quality
Operator Training and Certification Unit

Waste Stabilization Lagoons

A carefully designed structure constructed to contain and to facilitate the operation and control of a complex process of treating or stabilizing wastewater.

Typical Lagoon System



WASTEWATER

Water used to carry waste products away from homes, schools, commercial establishments, and industrial enterprises.

WASTE STABILIZATION LAGOON

In a Waste Stabilization Lagoon the Components in the Wastewater are Changed so that there is Little or No Additional Change

Purpose:

Provide for the Operation and Control of Complex Process

"Stabilizing" Components Under Control

Minimizing Hazards when Discharged

WASTE STABILIZATION LAGOON

In a Waste Stabilization Lagoon the Components in the Wastewater are Changed so that there is Little or No Additional Change

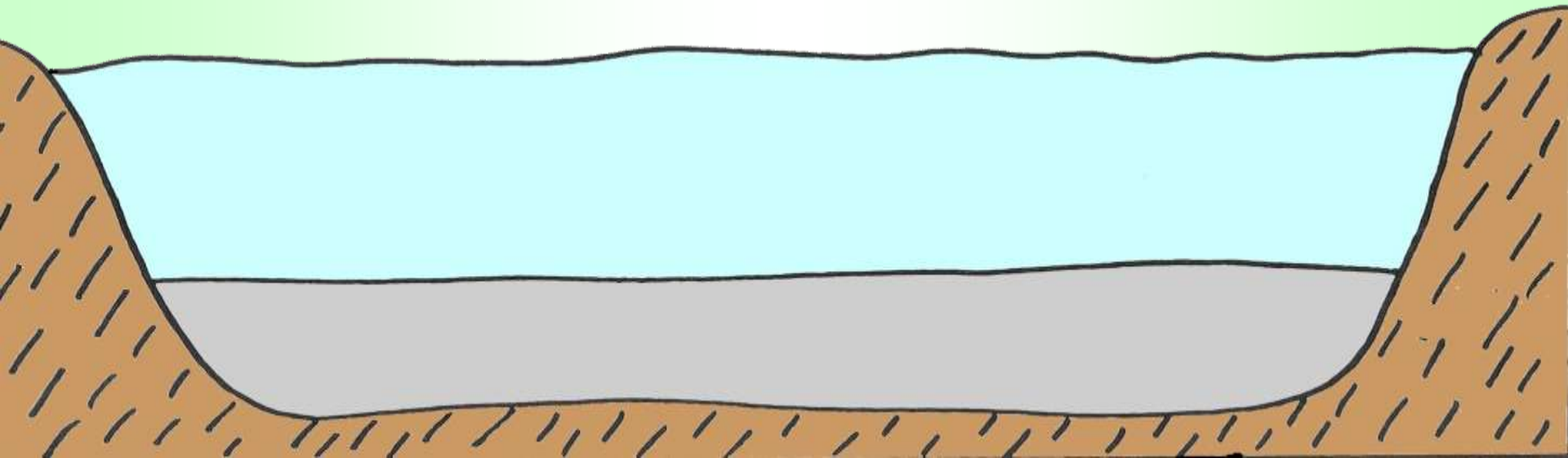
Operators Responsibility:

Ensure Efficient Operation

Protect Environment

Protect Human Health

TREATMENT PROCESS



Waste Stabilization Lagoons
"Treatment" Process

Natural Process

Same Process Which Occurs in a Natural Pond or Lake

Under Controlled Conditions

Waste Stabilization Lagoons

Natural Process

Same as Mechanical Plants

Carefully Designed and Constructed

Must Be Operated Properly

Must Be Understood

Waste Stabilization Lagoons

"The Process" Involves:

Physical Processes

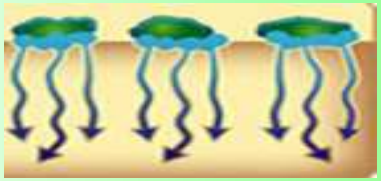
Chemical Processes

and

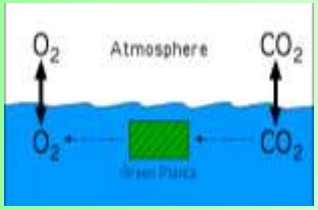
Biological Processes

Physical Processes

Evaporation



Seepage



Gas Exchange

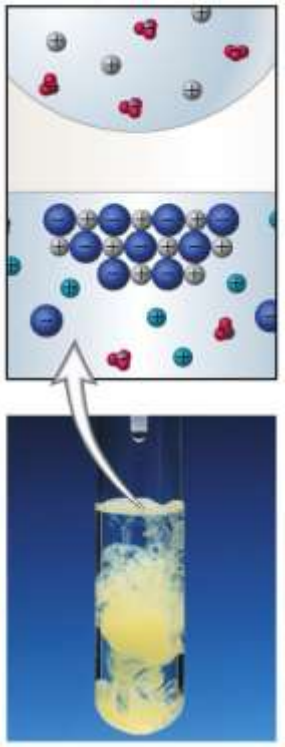
SOLIDS

Sedimentation

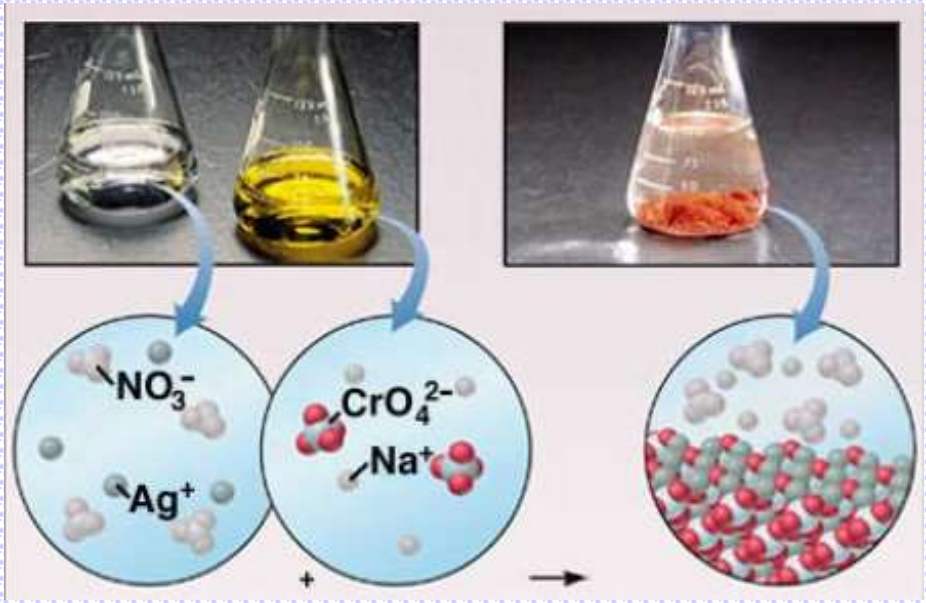
U.V. Radiation

Chemical Processes

Inorganic Activity



Precipitation Formation



Wastewater "Treatment" Process

Mostly BIOLOGICAL

BACTERIA

BACTERIA
Types

Aerobic

Bacteria that can use only oxygen that is "free" or not chemically combined.

Anaerobic

Bacteria that can live in the absence of "free" oxygen.

Facultative

Bacteria that use either "free" or combined oxygen.

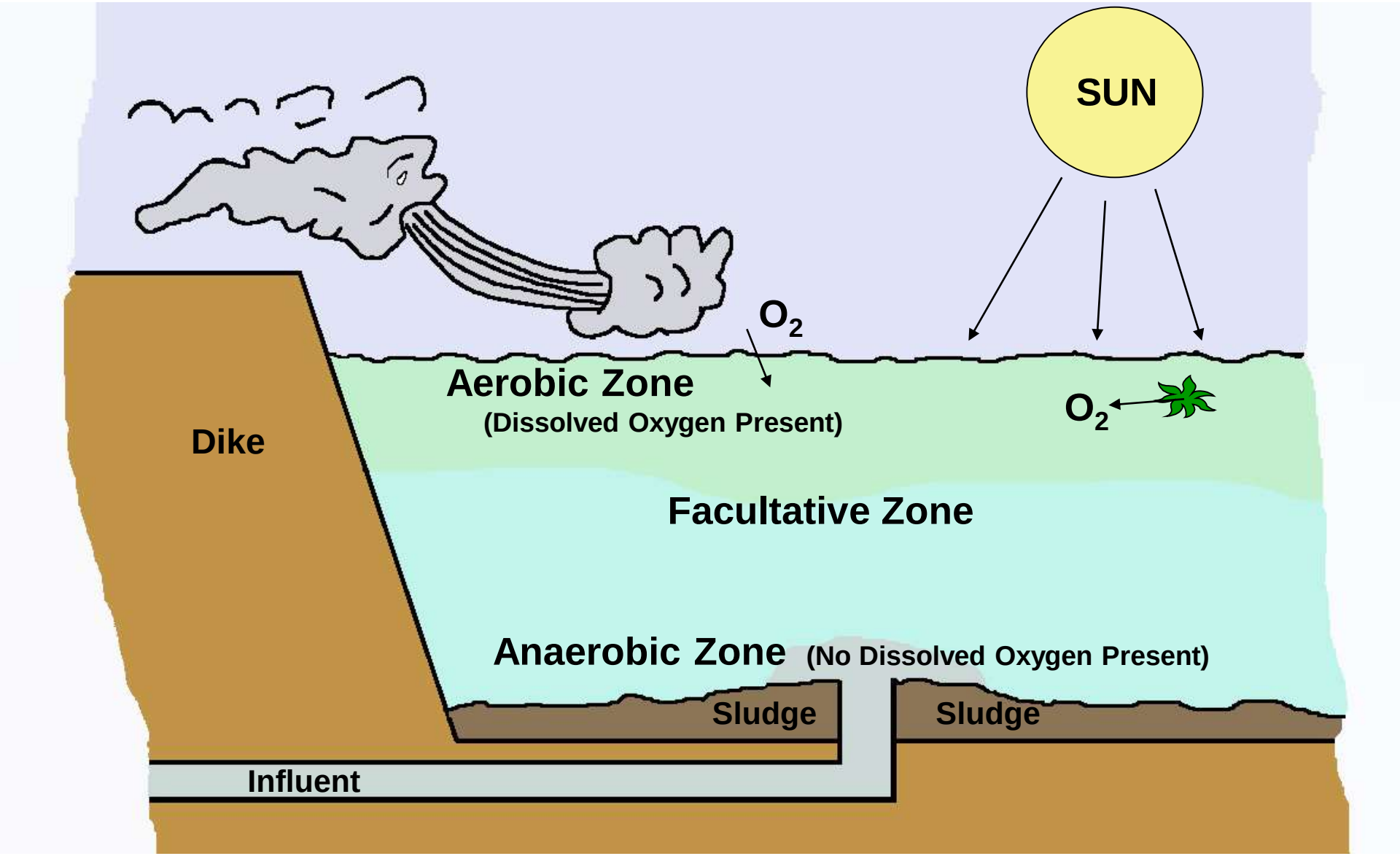
Zones in a Lagoon

AEROBIC

FACULTATIVE

ANAEROBIC

Zonal Relationships in a Lagoon



Zonal Differences

Environments

Bacteria

Activities

ANAEROBIC ZONE

Sedimentation

SOLIDS

Stabilization

Organics 

Organic Acids

Organic Acids 

Carbon Dioxide (CO_2)
Ammonia (NH_3)
Hydrogen Sulfide (H_2S)
Methane (CH_4)

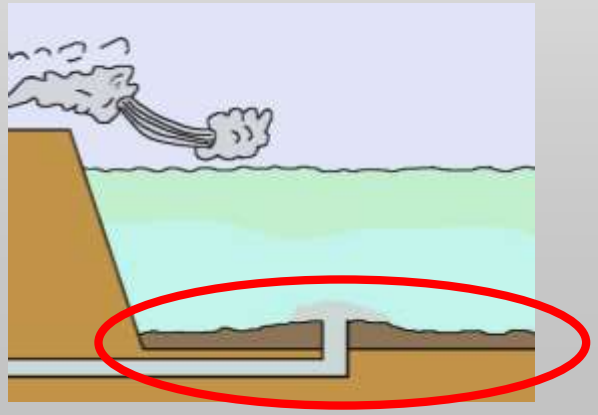
ANAEROBIC ZONE

Sedimentation

SOLIDS

Stabilization

Not All Of the Settled Solids Will Be Broken Down.



The Sludge Layer Will Increase Slowly Over the Life of the Lagoon

AEROBIC ZONE

Bacteria Use Soluble Organics

Influent

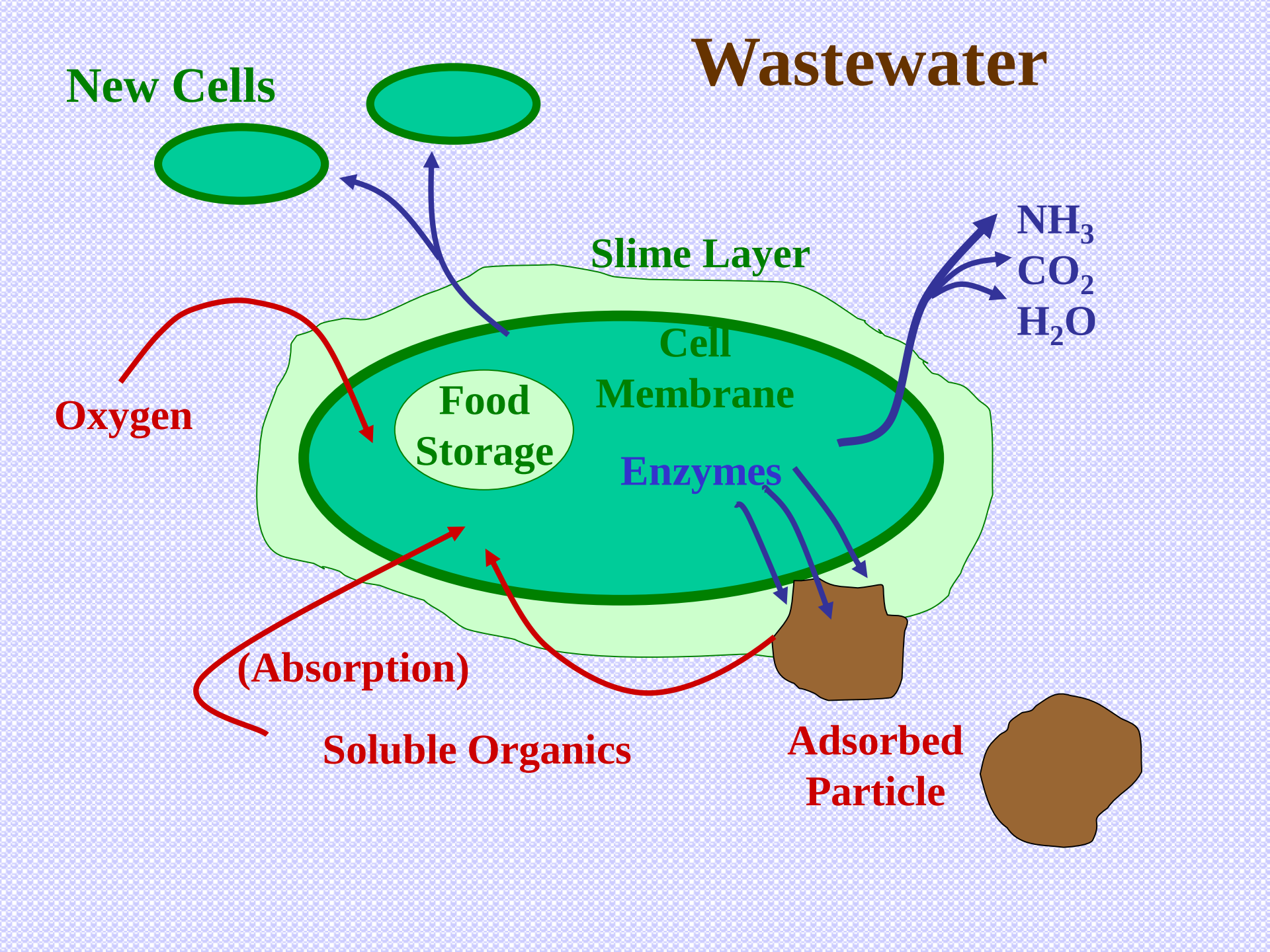
Anaerobic Zone

Respiration

RESIPRATION

Organic Compounds + Oxygen → Carbon Dioxide + Water

$CH_2O + O_2 \rightarrow CO_2 + H_2O$


Wastewater
New Cells
Slime Layer
NH_3
CO_2
H_2O
Cell
Membrane
Food
Storage
Oxygen
Enzymes
(Absorption)
Soluble Organics
Adsorbed
Particle

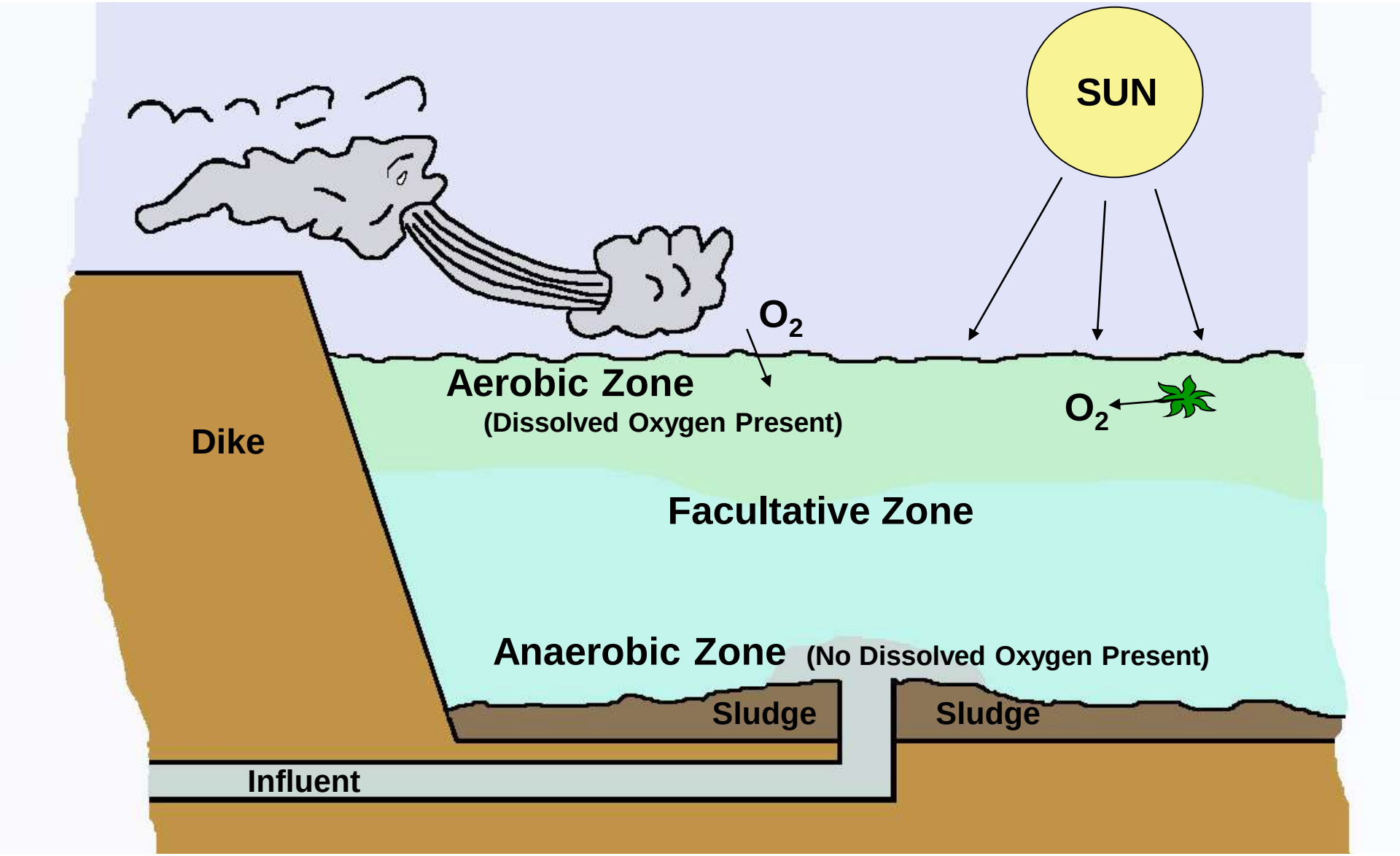
FACULTATIVE ZONE

Organisms Utilize Dissolved Oxygen or Combined Oxygen

Adapt to Changing Conditions

Continue Decomposition During Changing Conditions

Zonal Relationships in a Lagoon



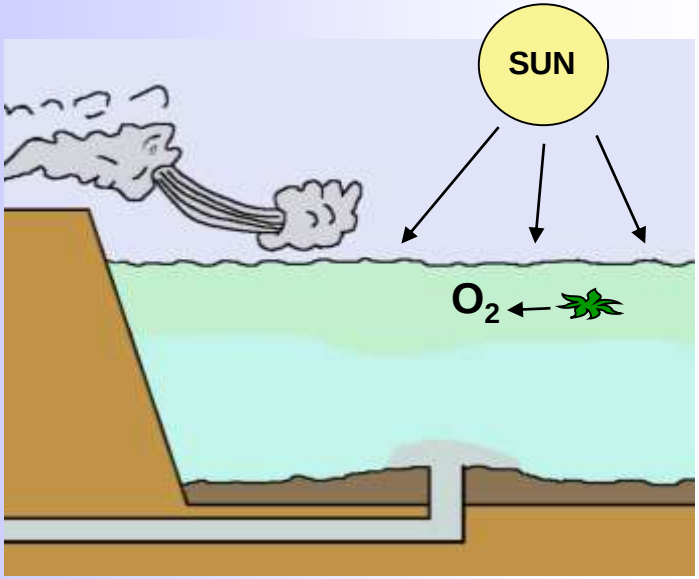
Importance of Sufficient Oxygen

Efficient Treatment

Preventing Odors

Sources of Oxygen

ABSORPTION from ATMOSHERE



PHOTOSYNTHESIS

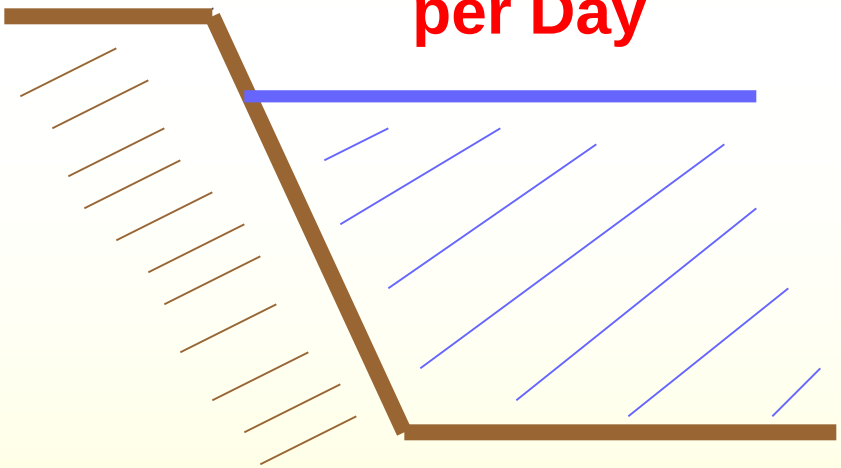
PHOTOSYNTHESIS

A Process
in which
PLANTS
Utilize Sunlight and Chlorophyll
to Convert
Carbon Dioxide and Inorganic
Substances
to
OXYGEN
and
Additional Plant Material

OXYGEN SOURCES

Surface Aeration Provides

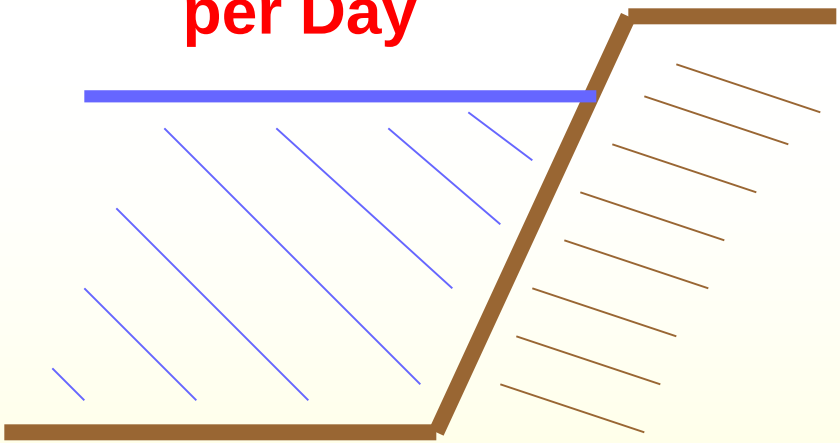
6 Pounds per Acre per Day



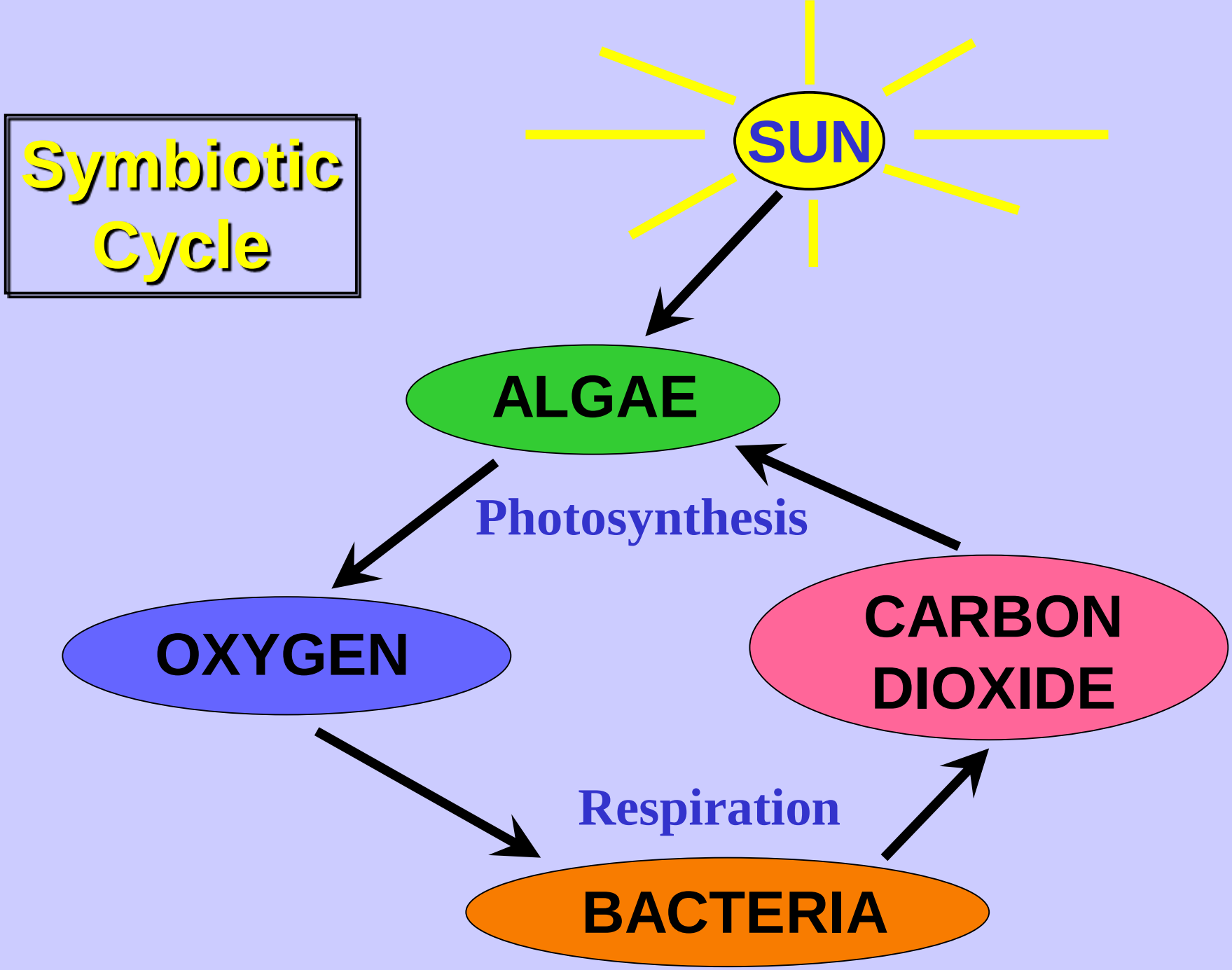
At Lagoon D.O. of 2.0 mg/L
Temperature Permitting 8.0 mg/L

Algae (Photosynthesis) Provides

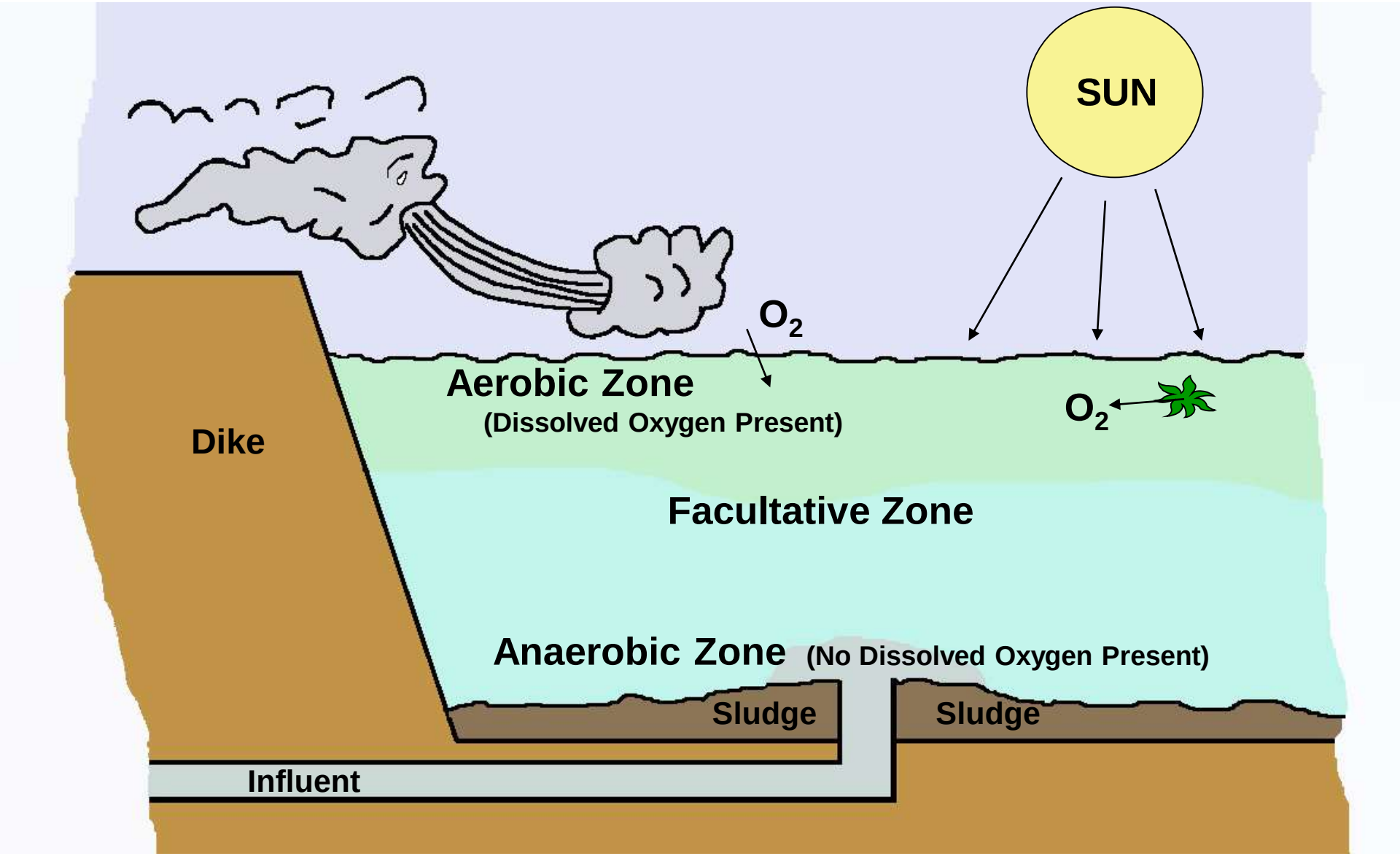
100 Pounds per Acre per Day



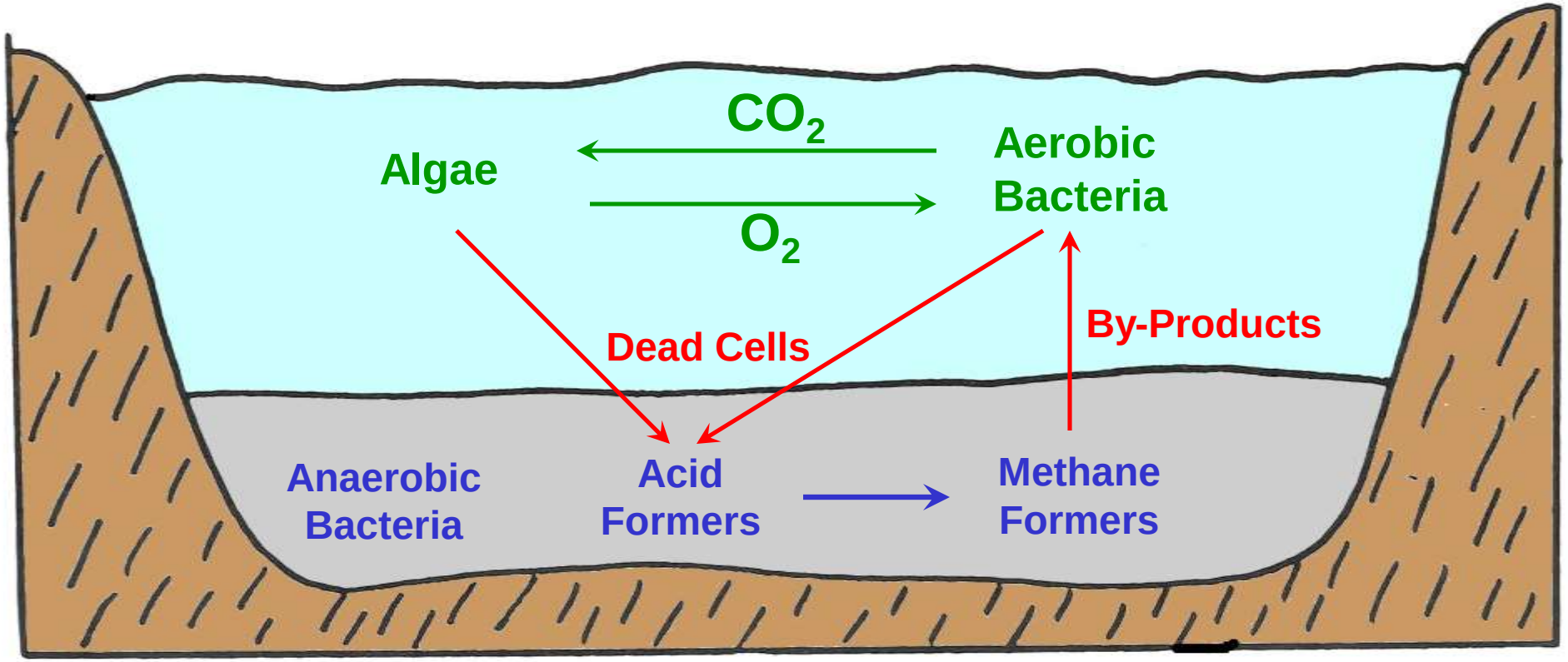
Each 60 Pounds of Algae
Produce 100 pounds Oxygen

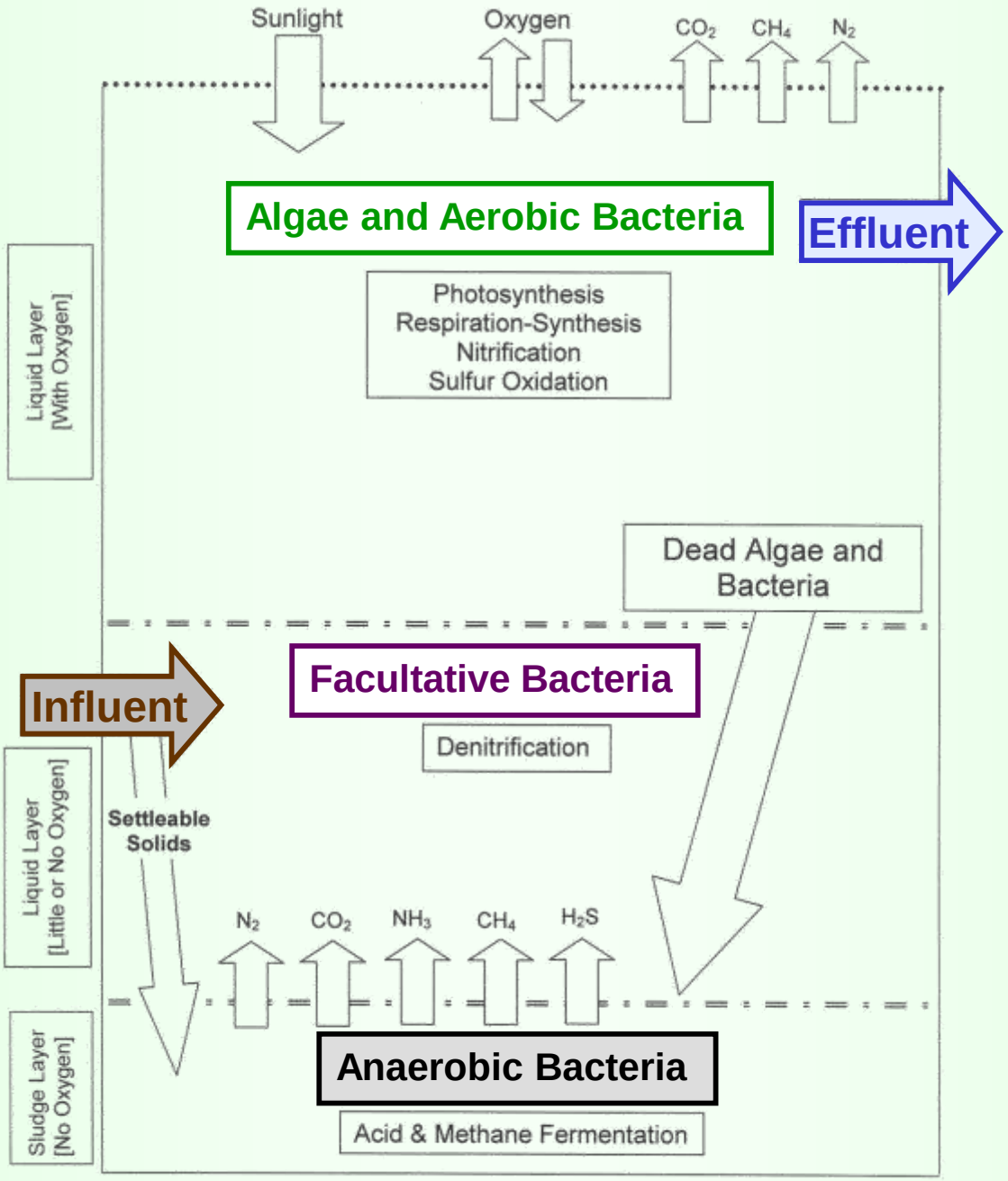

Symbiotic Cycle
SUN
ALGAE
Photosynthesis
OXYGEN
CARBON DIOXIDE
Respiration
BACTERIA

Zonal Relationships in a Lagoon



ACTIVITY IN FACULTATIVE PONDS

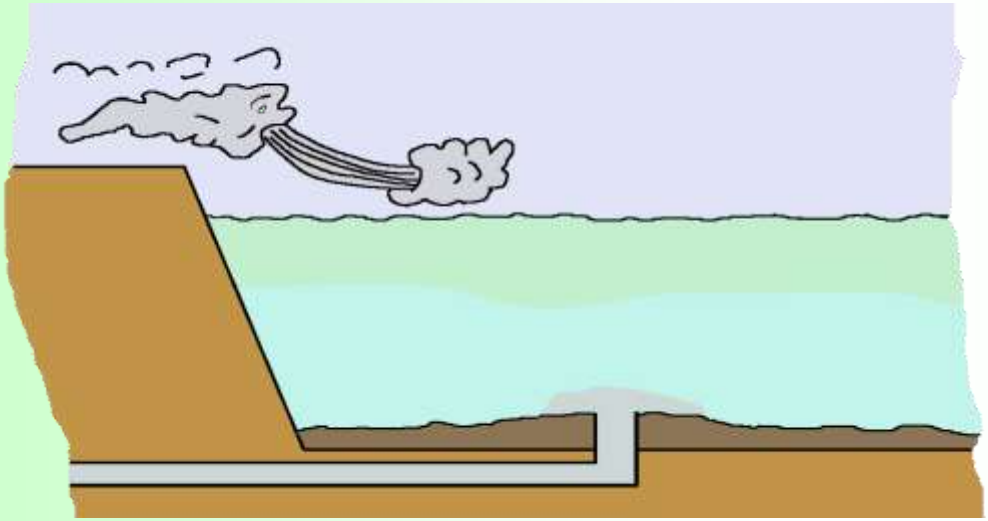




ACTIVITY IN FACULTATIVE LAGOONS

FACTORS THAT AFFECT THE TREATMENT PROCESS

Influence of Wind



Adds Oxygen

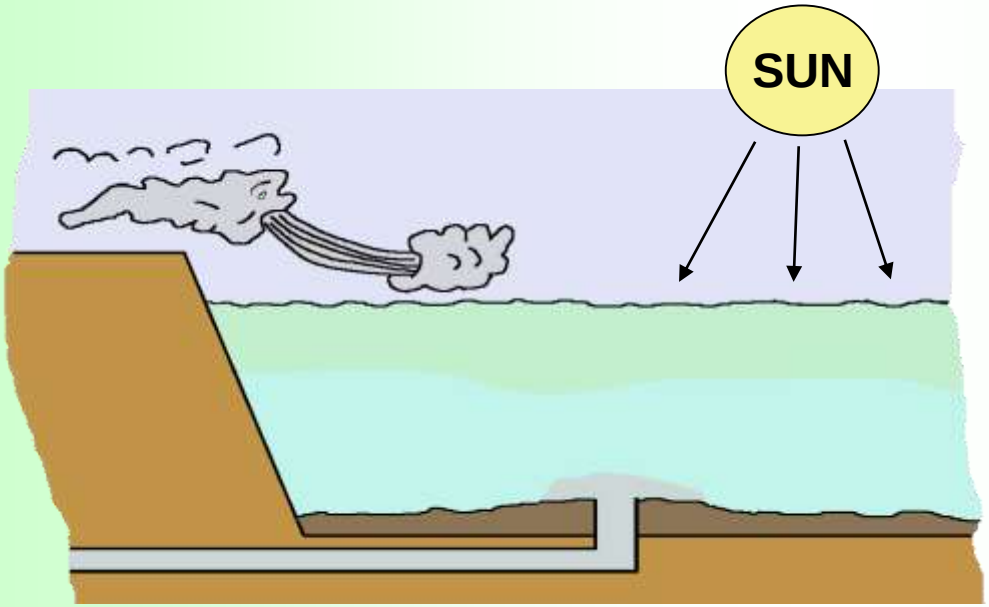
Increases Mixing

Must Be Controlled

By Minimizing Accumulations of Material On, In, or Around the Lagoon

FACTORS THAT AFFECT THE TREATMENT PROCESS

Influence of Light



Photosynthesis

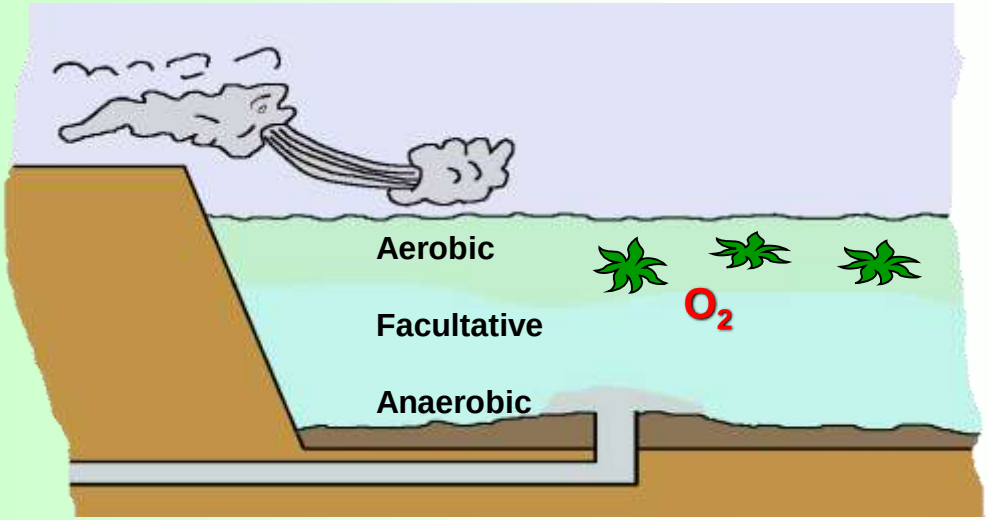
Disinfection

Must Be Controlled

By Minimizing Accumulations of Material On, In, or Around the Lagoon

FACTORS THAT AFFECT THE TREATMENT PROCESS

Influence of Temperature



Rate of Bacterial Activity

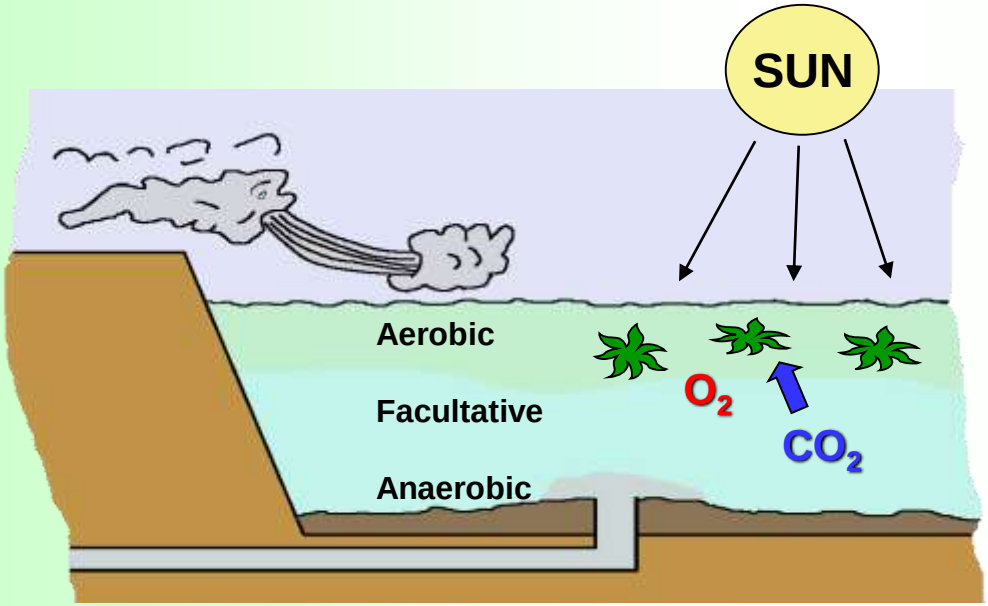
Growth of Algae

D.O. Saturation

Must Be Considered

FACTORS THAT AFFECT THE TREATMENT PROCESS

Daily Fluctuations



Temperature

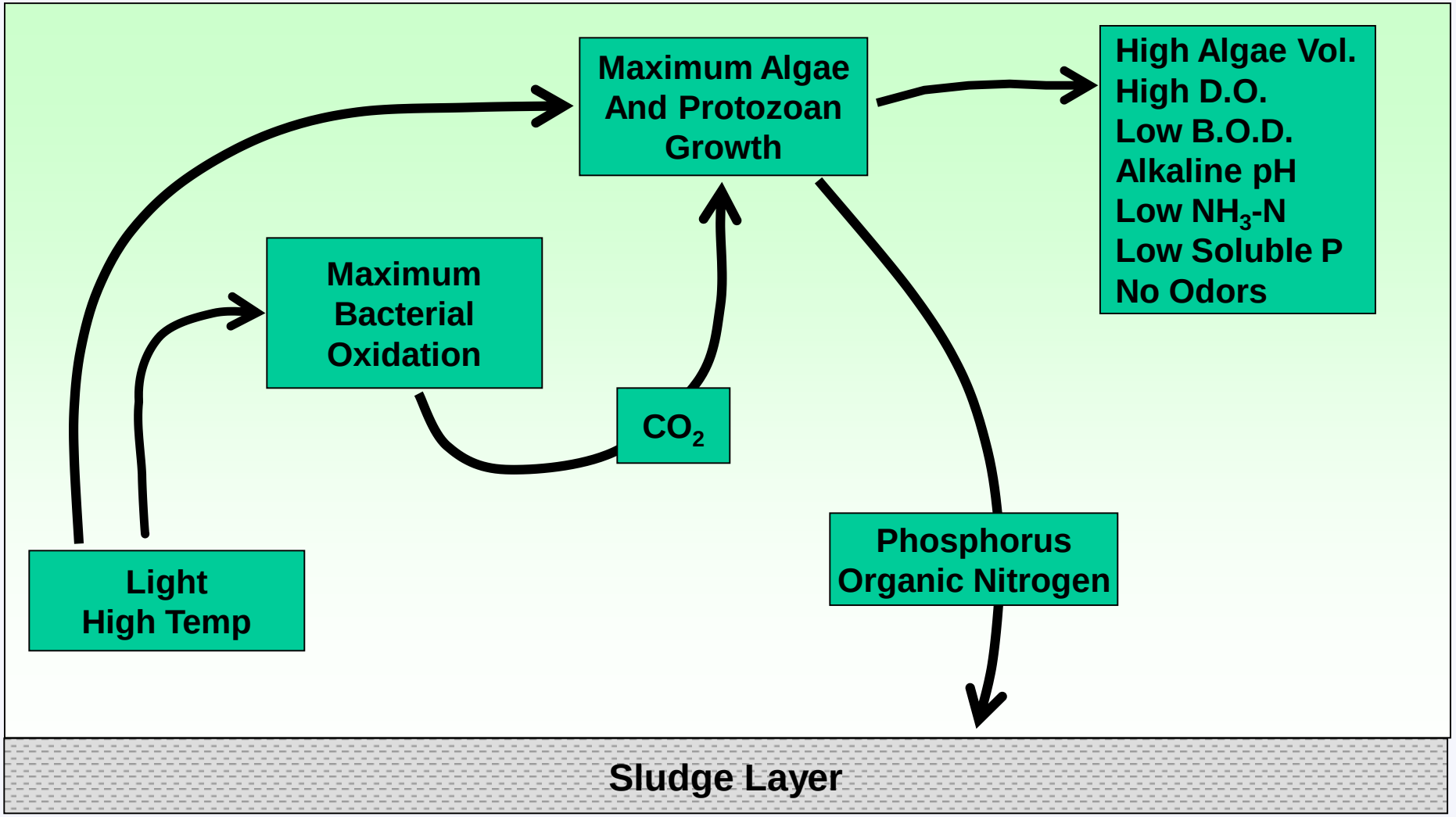
Dissolved Oxygen

pH

Must Be Considered

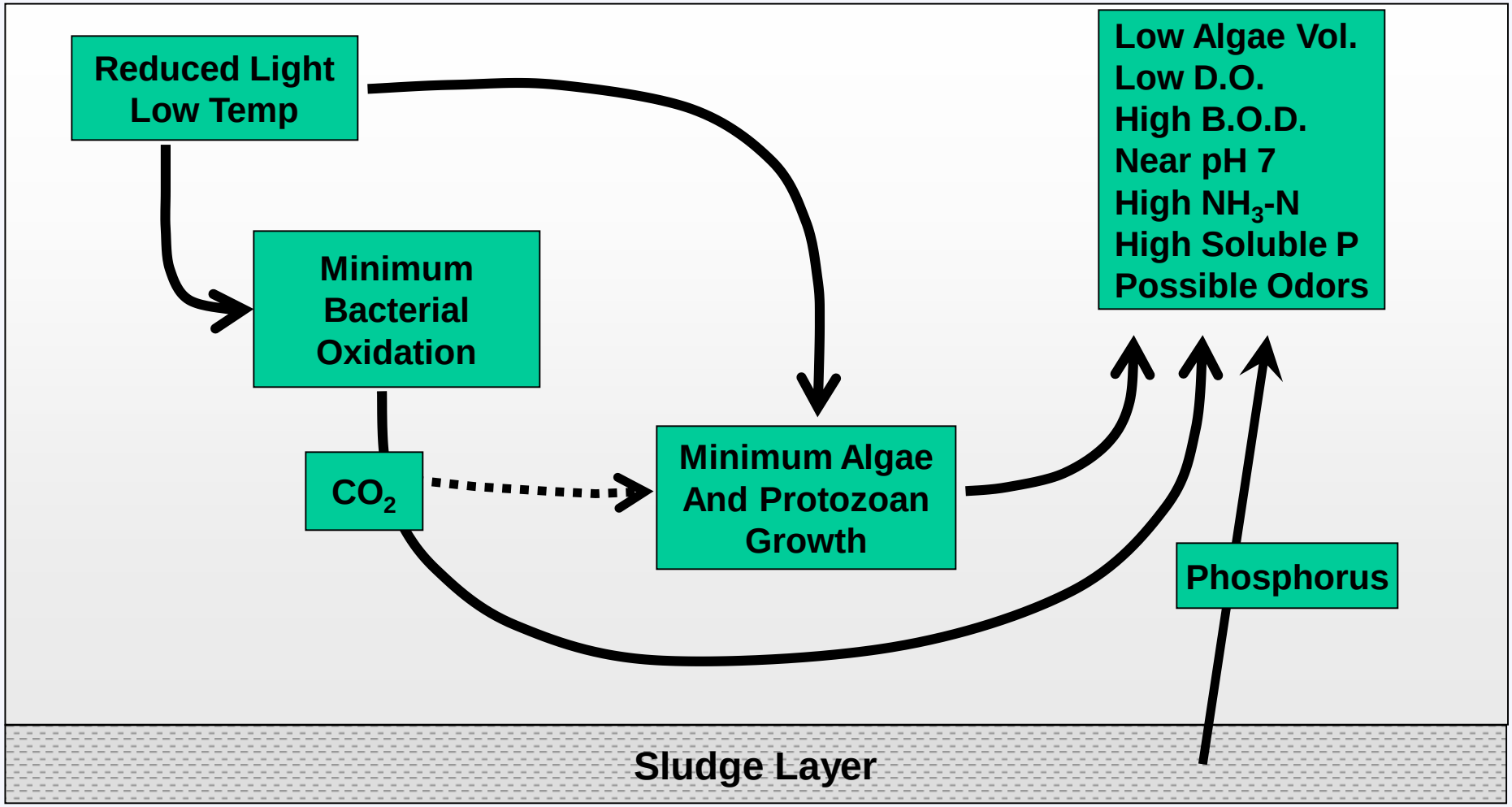
SEASONAL VARIATIONS

Summer To Fall



SEASONAL VARIATIONS

Winter To Early Spring



SEASONAL VARIATIONS

Spring and Fall

Transition Periods

Optimum for Discharging

Within Permit Limits
High Stream Flows - Dilution
High D.O. - Lagoon and Receiving Stream
Minimal Human Contact

ADVANTAGES of LAGOON SYSTEMS

1. Economical to Construct & Operate.
2. Low Monitoring & Control Requirements.
3. Rapid Recovery from “Shock” Loads.
4. Low Energy & Chemical Usage.
5. Low Mechanical Failure.
6. Minimal Sludge Disposal.
7. Long Life.

DISADVANTAGES of LAGOON SYSTEMS

1. Large Land Usage.
2. Low Control Options.
3. Operations Dependant on Climate.
4. Often High Suspended Solids.
5. Seasonal Odors.
6. Possible Ground Water Contamination.
7. Not Good In High Loading Situations.

RESULTS of PROCESS

Public Health Protected

- Pathogens Removed

Environment Protected

- Characteristics of Wastewater Changed
- End Products Stable

Process Itself Is Not Offensive












GOOD RESULTS

IF

Process Is In Balance

Properly Designed Facility

Process Is Controlled

System Is Maintained

Waste Stabilization Lagoons

A carefully designed structure constructed to contain and to facilitate the operation and control of a complex process of treating or stabilizing wastewater.

One Very Important Tool of Design and Operation Is The Ability and Use of

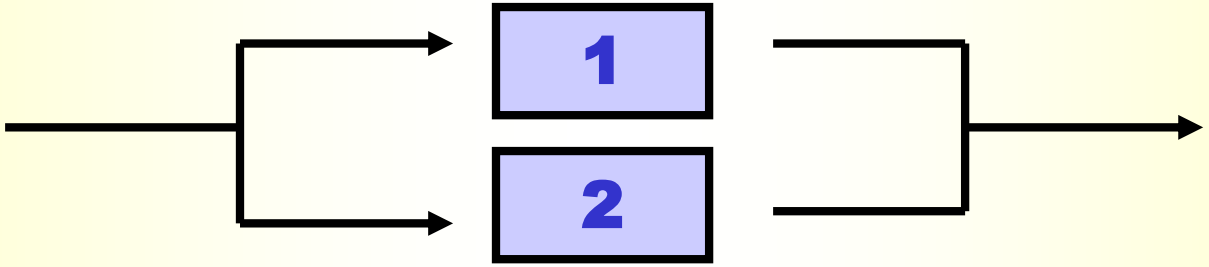
Series or Parallel

Flow Through the System

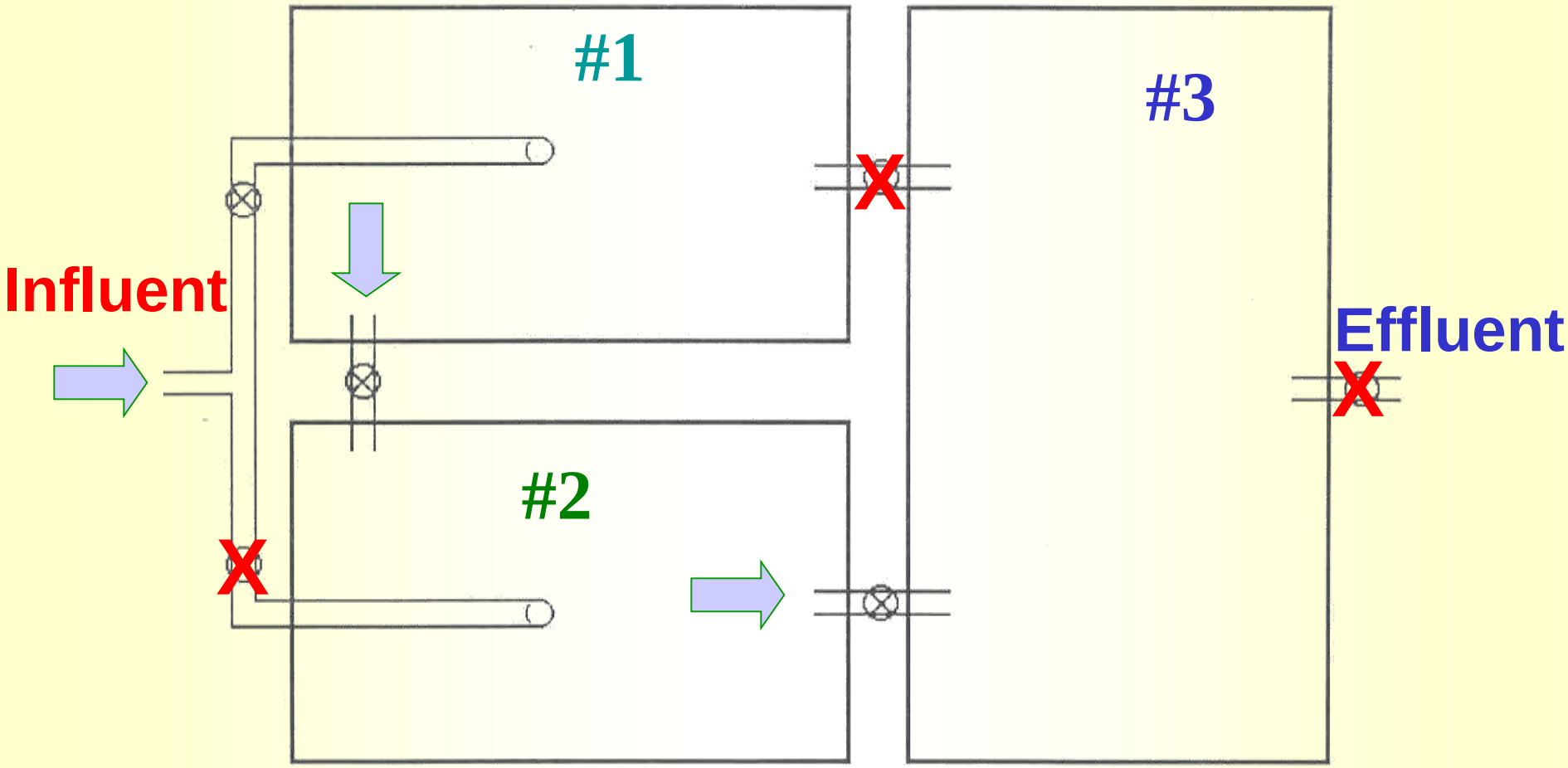
Series

OR

Parallel

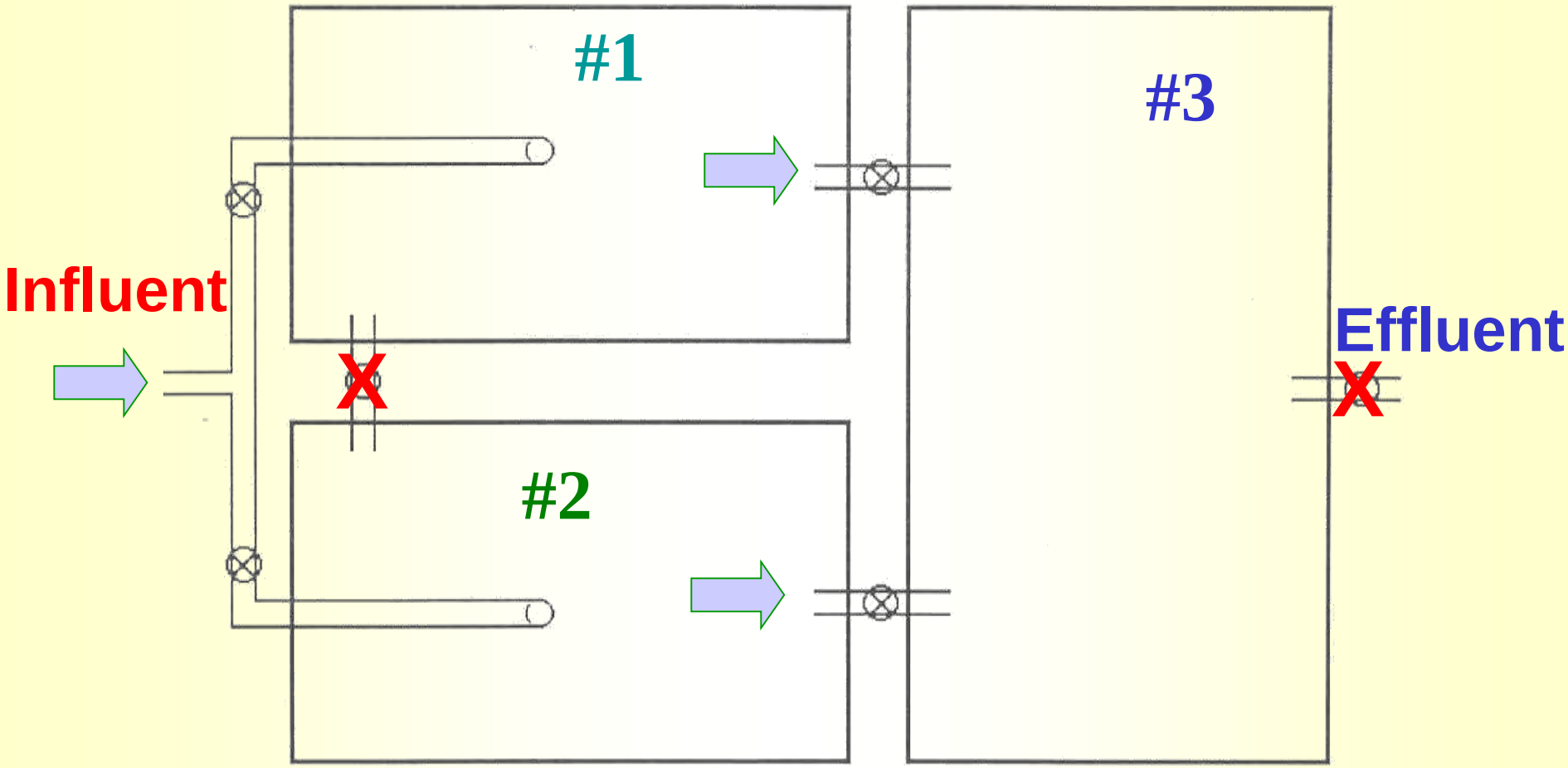


Typical Lagoon System



SERIES OPERATION

Typical Lagoon System



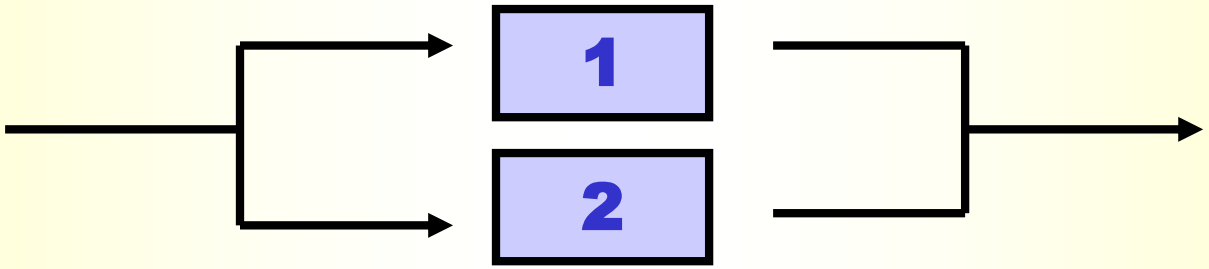
PARALLEL OPERATION

Series

Placing Majority of Load on First Cell

Summer Operation

Parallel



Dividing Organic Load Between At Least Two Cells

Winter Operation

Loading

Amount Applied to the Treatment Process

Related to the SIZE of the System

For Lagoons

Surface Area of the System

Loading

Amount Applied to the Treatment Process

Population Loading

Hydraulic Loading

Organic Loading

POPULATION LOADING

Number of Persons per Acre

$$= \frac{\text{Population Served (persons)}}{\text{Area of Lagoon (Acres)}}$$

General

50 to 500 Persons per Acre

Michigan

100 Persons per Acre

Hydraulic Loading

VOLUME of Wastewater to be Treated

Flow Rate

Gallons per Day (gpd)

OR

Million Gallons per Day (MGD)

Inches per Day

$$= \frac{\text{Influent Rate (gallons per day)}}{\text{Pond Volume (gallons per inch)}}$$

Hydraulic Loading

Detention Time

$$= \frac{\text{Pond Volume (gallons)}}{\text{Influent Rate (gal. / Day)}}$$

Example:

Calculate the Detention Time for a lagoon with a volume of 720,000 gallons that receives a flow of 24,000 gallons per day.

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$= \frac{720{,}000 \text{ gallons}}{24{,}000 \text{ gallons/day}} = 30 \text{ Days}$$

Example Problems
Detention Time

1. What is the detention time in a 520,000 gallon lagoon that receives a flow of 20,000 gallons per day?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{520{,}000 \text{ gallons}}{20{,}000 \text{ gallons/day}}$$

$$= 26 \text{ Days}$$

Example Problems
Detention Time

2. What is the detention time in a 1,170,000 gallon lagoon that receives a flow of 0.065 MGD?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{1{,}170{,}000 \text{ gallons}}{0.065 \text{ MGD}}$$

0.065 MGD X 1,000,000 = 65,000 gal/day

$$\text{Det. Time} = \frac{1{,}170{,}000 \text{ gallons}}{65{,}000 \text{ gallons/day}}$$

= 18 Days

Practice Problems
Detention Time

Work Calculations on Separate Paper
Answers Given on Next Slides

3. What is the detention time in a 6,750,000 gallon storage pond that receives a flow of 45,000 gallons per day?

4. What is the detention time in a 432,000 gallon lagoon that receives a flow of 0.012 MGD?

Practice Problems
Detention Time

3. What is the detention time in a 6,750,000 gallon storage pond that receives a flow of 45,000 gallons per day?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{6{,}750{,}000 \text{ gallons}}{45{,}000 \text{ gallons/day}}$$

$$= 150 \text{ Days}$$

Practice Problems
Detention Time

4. What is the detention time in a 432,000 gallon lagoon that receives a flow of 0.012 MGD?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{432{,}000 \text{ gallons}}{0.012 \text{ MGD}}$$

0.012 MGD X 1,000,000 = 12,000 gal/day

$$\text{Det. Time} = \frac{432{,}000 \text{ gallons}}{12{,}000 \text{ gallons/day}}$$

= 36 Days

OR

Practice Problems
Detention Time

4. What is the detention time in a 432,000 gallon lagoon that receives a flow of 0.012 MGD?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{432{,}000 \text{ gallons}}{0.012 \text{ MGD}}$$

$$432{,}000 \text{ gallon} \div 1{,}000{,}000 = 0.432 \text{ MG}$$

$$\text{Det. Time} = \frac{0.432 \text{ MG}}{0.012 \text{ MGD}}$$

$$= 36 \text{ Days}$$

Hydraulic Loading

Detention Time

$$= \frac{\text{Pond Volume (gallons)}}{\text{Influent Rate (gal. / Day)}}$$

Need

30 to 120 Days

Design Storage

DESIGN STORAGE

Seasonal Discharge

From 2 Foot Level
to Maximum Operating Level

180 Days in Michigan

Hydraulic Loading

Detention Time

$$= \frac{\text{Pond Volume (gallons)}}{\text{Influent Rate (gal. / Day)}}$$

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

Calculate Regularly
Monitor Trends

Hydraulic Loading

Detention Time

$$= \frac{\text{Pond Volume (gallons)}}{\text{Influent Rate (gal. / Day)}}$$

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

Calculation Reliability
Depends on
Flow Measurement Reliability

Hydraulic Loading

Detention Time

$$= \frac{\text{Pond Volume (gallons)}}{\text{Influent Rate (gal. / Day)}}$$

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

Several Ways to Determine Flow

Can Use Timer and Pump Output

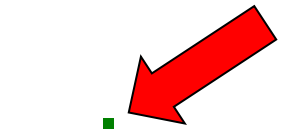
Example
Flow Rate Calculations

Volume Pumped = Rate X Time

Flow Rate Calculations

1. A pump rated at 125 gpm was on for 50 minutes. How much water was pumped in gallons?

Volume Pumped = Rate X Time



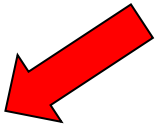
Volume Pumped = 125 $\frac{\text{gal}}{\cancel{\text{min}}}$ X 50 $\cancel{\text{min}}$

= 6250 gallons

Flow Rate Calculations

2. A pump rated at 150 gpm was on for 3 hours.
   How much water was pumped in gallons?

Volume Pumped = Rate X Time



$$\text{Volume Pumped} = 150 \frac{\text{gal}}{\text{min}} \times 3 \text{ hours}$$

3 hours X 60 min/hour = 180 min

150 X 3 = 450 gallons ?

$$\text{Volume Pumped} = 150 \frac{\text{gal}}{\text{min}} \times 180 \text{ min}$$

= 27,000 gallons

Flow Rate Calculations

3. A pump rated at 150 cfm was on for 250 minutes. How much water was pumped in gallons?

Volume Pumped = Rate X Time

Volume Pumped = 150 $\frac{ft^3}{min}$ X 250 min

150 ft^3 X 7.48 gallon/ft^3 = 1,122 gallons

150 X 250 = 37,500 gallons ?

150 ft^3/min = 1,122 gal/min

Volume Pumped = 1,122 $\frac{gal}{\cancel{min}}$ X 250 $\cancel{min}$

= 280,500 gallons

Flow Rate Calculations

LOOK AT THE TERMS

1. A pump rated at 125 gpm was on for 50 minutes.
   How much water was pumped in gallons?

OK !

2. A pump rated at 150 gpm was on for 3 hours.
   How much water was pumped in gallons?

Change TIME Term

3. A pump rated at 150 cfm was on for 250 minutes.
   How much water was pumped in gallons?

Change VOLUME Term

Work Calculations on Separate Paper
Answers Given on Next Slides

4. A pump rated at 250 gpm was on for 450 minutes.
   How much water was pumped in gallons?

5. A pump rated at 50 gpm was on for 9 hours.
   How much water was pumped in gallons?

6. A pump rated at 20 cfm was on for 125 minutes.
   How much water was pumped in gallons?

Flow Rate Calculations

4. A pump rated at 250 gpm was on for 450 minutes. How much water was pumped in gallons?

Volume Pumped = Rate X Time

$$\text{Volume Pumped} = 250 \frac{\text{gal}}{\cancel{\text{min}}} \times 450 \cancel{\text{min}}$$

= 112,500 gallons

Flow Rate Calculations

5. A pump rated at 50 gpm was on for 9 hours.
How much water was pumped in gallons?

$$\text{Volume Pumped} = \text{Rate} \times \text{Time}$$

$$\text{Volume Pumped} = 50 \frac{\text{gal}}{\text{min}} \times 9 \text{ hours}$$

$$9 \text{ hours} \times 60 \text{ min/hour} = 540 \text{ min}$$

$$\text{Volume Pumped} = 50 \frac{\text{gal}}{\cancel{\text{min}}} \times 540 \cancel{\text{min}}$$

= 27,000 gallons

Flow Rate Calculations

6. A pump rated at 20 cfm was on for 125 minutes. How much water was pumped in gallons?

Volume Pumped = Rate X Time

$$\text{Volume Pumped} = 20 \frac{ft^3}{min} \times 125 \text{ min}$$

$20\ ft^3 \times 7.48\ gallon/ft^3 = 149.6\ gallons$

$20\ ft^3/min = 149.6\ gal/min$

$$\text{Volume Pumped} = 149.6 \frac{gal}{\cancel{min}} \times 125\ \cancel{min}$$

OR

= 18,700 gallons

Flow Rate Calculations

6. A pump rated at 20 cfm was on for 125 minutes. How much water was pumped in gallons?

Volume Pumped = Rate X Time

$$\text{Volume Pumped} = 20 \frac{ft^3}{\cancel{min}} \times 125 \cancel{min}$$

$$\text{Volume Pumped} = 2{,}500\ ft^3$$

$$2{,}500\ ft^3 \times 7.48\ gallon/ft^3$$

$$= 18{,}700\ \text{gallons}$$

ORGANIC LOADING

Pounds BOD per Day per Acre

$$= \frac{\text{BOD, pounds per day}}{\text{Pond Area, acres}}$$

General

10 to 50 Pound BOD per Day per Acre

Michigan

20 Pounds BOD per Day per Acre
ALL CELLS

35 Pounds BOD per Day per Acre
SINGLE CELL

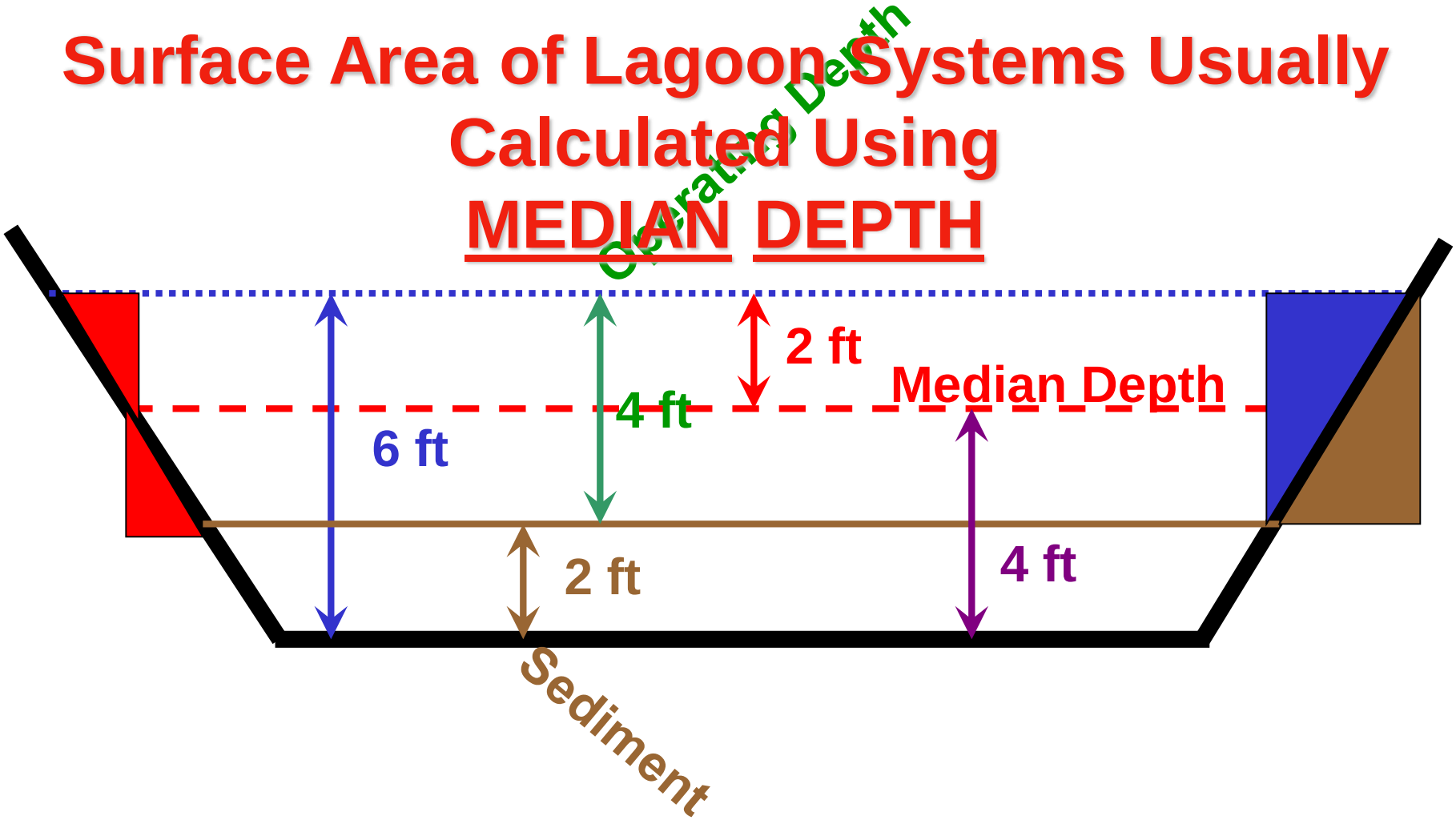
ORGANIC LOADING

Pounds BOD per Day per Acre

$$= \frac{\text{BOD, pounds per day}}{\text{Pond Area, acres}}$$

Surface Area

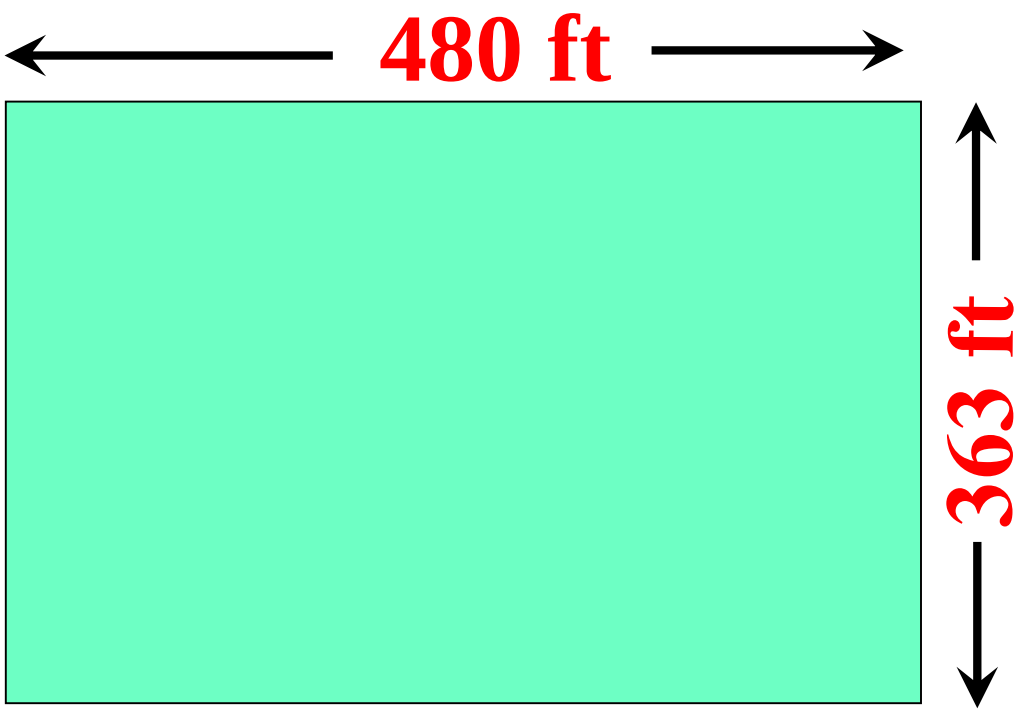
Surface Area of Lagoon Systems Usually Calculated Using MEDIAN DEPTH



Median Depth is 1/2 the depth of the volume considered for storage.

Example Median Depth Problem

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.



Dimensions at MEDIAN DEPTH

Example Median Depth Problem

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

A. Calculate the Surface Area at median depth in square feet.

Area is always two dimensions.

For a rectangle:

Area = Length X Width

Area = 480 ft. X 363 ft.

= 174,240 ft^2

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

B. Calculate the Surface Area in acres.

$$1 \text{ Acre} = 43{,}560 \text{ ft}^2$$

$$\text{Area in Acres} = \frac{\text{Area in ft}^2}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$\frac{174{,}240 \text{ ft}^2}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$= 4 \text{ acre}$$

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

C. Calculate the Operating Volume in cubic feet.

Volume = Length X Width X Depth

Volume = Area X Depth

174,240 ft^2 X 4 ft

= 696,960 ft^3

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

D. Calculate the Operating Volume in gallons.

$1\ ft^3 = 7.48$ gallons

Volume in Gallons =

Volume in ft^3 X 7.48 gallons / ft^3

696,960 ft^3 X 7.48 gallons / ft^3

= 5,213,261 gallons

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

E. Calculate the gallons per inch of depth.

Depth = 4 feet

1 foot = 12 inches

$$4 \text{ ft} \times \frac{12 \text{ in}}{\text{ft}} = 48 \text{ inches}$$

$$\frac{\text{gallons}}{\text{inch}} = \frac{5{,}213{,}261 \text{ gallons}}{48 \text{ inches}}$$

= 108,610 gal/inch

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

E. Calculate the gallons per inch of depth.

= 108,610 gal/inch

Use To Check:

- **Discharge Amount**
- **Influent Rate**
- **Meter Accuracy**
- **Leaks in Seal**

A lagoon measures 480 feet long and 363 feet wide at the median depth. The lagoon operating depth is 4 feet.

F. How many inches would the water level drop if 1,310,000 gallons were discharged?

$$\frac{1{,}310{,}000 \text{ gallons}}{108{,}610 \text{ gal/inch}}$$

$$= 12.1 \text{ inches}$$

ORGANIC LOADING

Pounds BOD per Day per Acre

$$= \frac{\text{BOD, pounds per day}}{\text{Pond Area, acres}}$$

CALCULATION OF POUNDS

We often need to know how many pounds of material we are dealing with.

1. Loading on treatment system.
2. Calculating pounds of a chemical to add.
3. Calculating pounds of a material being discharged.

CALCULATION OF POUNDS

Three things must be known to calculate the POUNDS of material in a quantity of water.

1. **The Quantity of water must be known.**
   (The flow of the water stream or the volume of the tank containing the water.)

2. **The Concentration of material in water must be known. (Lab analysis)**

3. **The Weight of a gallon of water**

The Weight of a gallon of water is a constant.

1 gallon of water weighs 8.34 pounds

CALCULATION OF POUNDS

Pounds =

Conc. x Flow (or Volume) x 8.34 Lbs/gallon

Concentration Of STUFF In the Water	X	Quantity Of Water The STUFF Is In	X	Weight Of The Water

Flow (volume) and concentration must be expressed in specific units.

Flow or volume must be expressed as millions of gallons:

$$\frac{\text{gallons}}{1{,}000{,}000\ \text{gal/MG}} = \text{MG}$$

i.e.) A tank contains 1,125,000 gallons of water. How many million gallons are there?

$$\frac{1{,}125{,}000\ \text{gal}}{1{,}000{,}000\ \text{gal/MG}} = 1.125\ \text{MG}$$

Concentration must be expressed as parts per million parts.

Concentration usually reported as milligrams per liter.
This unit is equivalent to ppm.

$$\frac{1\text{ mg}}{\text{liter}} = \frac{1\text{ mg}}{1000\text{ grams}} = \frac{1\text{ mg}}{1{,}000{,}000\text{ mg}} = \text{ppm}$$

$$\text{ppm} = \frac{\text{Parts}}{\text{Mil Parts}} = \frac{\text{Lbs.}}{\text{Mil Lbs.}}$$

When flow (volume) is expressed as MG and conc. is in ppm, the units cancel to leave only *pounds*.

Lbs. =

Concentration x Flow (or volume) x 8.34 lbs/gallon

$$\frac{\cancel{\text{Lbs.}}}{\cancel{\text{M}}\ \cancel{\text{Lbs.}}} \times \cancel{\text{M}}\ \cancel{\text{gal}} \times \frac{\text{Lbs.}}{\cancel{\text{gal}}}$$

= Lbs.

If we enter flow rate in M gal per day (MG/D), the answer will be in lbs/day.

$$\text{Lbs/day} = \text{conc. (mg/L)} \times \text{flow (MGD)} \times \frac{8.34 \text{ lbs}}{\text{gal}}$$

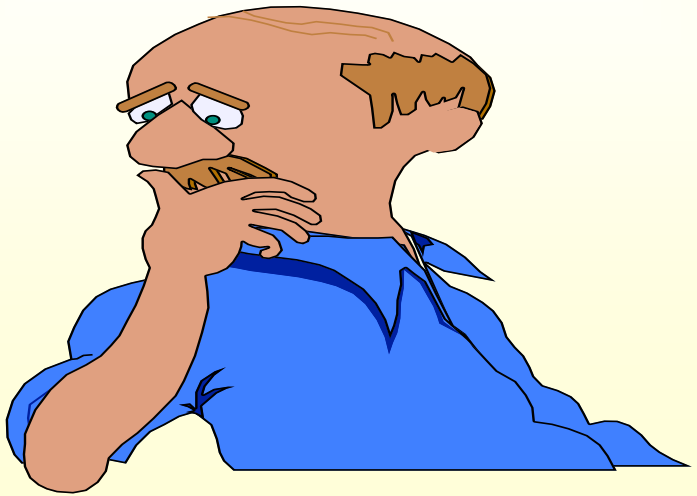
$$\frac{\cancel{\text{Lbs.}}}{\cancel{\text{M}}\ \cancel{\text{Lbs.}}} \times \frac{\cancel{\text{M gal}}}{\text{Day}} \times \frac{\text{Lbs.}}{\cancel{\text{gal}}}$$

$$= \text{Lbs./Day}$$

The lbs formula can be rearranged to calculate flow or concentration:

a. $$\text{M gal} = \frac{\text{lbs}}{8.34 \text{ lbs/gal} \times \text{conc. (mg/L)}}$$

b. $$\text{conc. (mg/L)} = \frac{\text{lbs}}{8.34 \text{ lbs/gal} \times \text{M gal.}}$$



The Pounds formula can be rearranged to calculate concentration or flow

Examples:

Concentration of chemical fed (Dosage).

$$\text{conc. (mg/L)} = \frac{\text{lbs}}{8.34 \text{ lbs/gal} \times \text{M gal.}}$$

Volume to discharge.

$$\text{M gal} = \frac{\text{lbs}}{8.34 \text{ lbs/gal} \times \text{conc. (mg/L)}}$$

Example Pounds Calculations

1. **Calculate the POUNDS of suspended solids discharged to the receiving stream if the suspended solids concentration was 18 mg/L and the plant flow was 0.20 MGD.**

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

POUNDS/day =

18 mg/L X 0.20 MGD X 8.34 #/gal

= 30.0 Lbs./day Suspended Solids

Example Pounds Calculations

2. **Calculate the POUNDS of BOD going to a lagoon system if the influent BOD concentration was 95 mg/L and the flow was 86,000 gallons/day.**

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

POUNDS/day =

$$95\ \text{mg/L} \times \frac{86{,}000\ \text{gal/day}}{1{,}000{,}000} \times 8.34\ \#/\text{gal}$$

= 95 mg/L X 0.086 MGD X 8.34 #/gallon

= 68.1 Lbs./day BOD

ORGANIC LOADING

Pounds BOD per Day per Acre

$$= \frac{\text{BOD, pounds per day}}{\text{Pond Area, acres}}$$

3. **What is the organic loading on a 4 acre lagoon that receives a flow of 0.075 MGD with an average BOD concentration of 128 mg/L.**

$$\text{Organic Load} = \frac{\text{Pounds BOD/day}}{\text{Acre}}$$

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

128 mg/L X 0.075 MGD X 8.34 #/gal

= 80.06 Lbs. BOD/day

$$\text{Organic Load} = \frac{\text{80.06 Lbs. BOD/day}}{\text{4 Acre}}$$

Organic Load = 20.0 # BOD/day/acre

4. What is the organic loading on a 6 acre lagoon that receives a flow of 85,000 gallons per day with an average BOD concentration of 144 mg/L.

$$\text{Organic Load} = \frac{\text{Pounds BOD/day}}{\text{Acre}}$$

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

$$= 144 \text{ mg/L} \times \frac{85{,}000 \text{ gal/day}}{1{,}000{,}000} \times 8.34 \text{ \#/gal}$$

$$= 144 \text{ mg/L} \times 0.085 \text{ MGD} \times 8.34 \text{ \#/gal}$$

$$= 102.08 \text{ Lbs. BOD/day}$$

$$\text{Organic Load} = \frac{102.08 \text{ Lbs. BOD/day}}{6 \text{ Acre}}$$

Organic Load = 17.0 # BOD/day/acre

Practice Calculations

Work Calculations on Separate Paper
Answers Given on Next Slides

5. Calculate the POUNDS of suspended solids discharged to the receiving stream if the suspended solids concentration was 15 mg/L and the plant flow was 0.12 MGD.

6. Calculate the POUNDS of BOD going to a lagoon system if the influent BOD concentration was 135 mg/L and the flow was 32,000 gallons/day.

7. What is the organic loading on a 5 acre lagoon that receives a flow of 0.15 MGD with an average BOD concentration of 142 mg/L.

8. What is the organic loading on a 2.6 acre lagoon that receives a flow of 35,000 gallons per day with an average BOD concentration of 144 mg/L.

Example Pounds Calculations

5. Calculate the POUNDS of suspended solids discharged to the receiving stream if the suspended solids concentration was 15 mg/L and the plant flow was 0.12 MGD.

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

POUNDS/day =

15 mg/L X 0.12 MGD X 8.34 #/gal

= 15.0 Lbs./day Suspended Solids

Example Pounds Calculations

6. **Calculate the POUNDS of BOD going to a lagoon system if the influent BOD concentration was 135 mg/L and the flow was 32,000 gallons/day.**

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

POUNDS/day =

$$135\ \text{mg/L} \times \frac{32{,}000\ \text{gal/day}}{1{,}000{,}000} \times 8.34\ \text{\#/gal}$$

= 135 mg/L X 0.032 MGD X 8.34 #/gallon

= 36.0 Lbs./day BOD

Example Pounds Calculations

7. **What is the organic loading on a 5 acre lagoon that receives a flow of 0.15 MGD with an average BOD concentration of 142 mg/L.**

$$\text{Organic Load} = \frac{\text{Pounds BOD/day}}{\text{Acre}}$$

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

142 mg/L X 0.15 MGD X 8.34 #/gal

= 177.64 Lbs. BOD/day

$$\text{Organic Load} = \frac{177.64 \text{ Lbs. BOD/day}}{5 \text{ Acre}}$$

Organic Load = 35.5 # BOD/day/acre

Example Pounds Calculations

8. What is the organic loading on a 2.6 acre lagoon that receives a flow of 35,000 gallons per day with an average BOD concentration of 144 mg/L.

$$\text{Organic Load} = \frac{\text{Pounds BOD/day}}{\text{Acre}}$$

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

$$= 144 \text{ mg/L} \times \frac{35{,}000 \text{ gal/day}}{1{,}000{,}000} \times 8.34 \text{ \#/gal}$$

$$= 144 \text{ mg/L} \times 0.035 \text{ MGD} \times 8.34 \text{ \#/gal}$$

$$= 42.0 \text{ Lbs. BOD/day}$$

$$\text{Organic Load} = \frac{42.0 \text{ Lbs. BOD/day}}{2.6 \text{ Acre}}$$

Organic Load = 16.2 # BOD/day/acre

ORGANIC LOADING

Pounds BOD per Day per Acre

$$= \frac{\text{BOD, pounds per day}}{\text{Pond Area, acres}}$$

General

10 to 50 Pound BOD per Day per Acre

Michigan

20 Pounds BOD per Day per Acre
ALL CELLS

35 Pounds BOD per Day per Acre
SINGLE CELL

Practice Problems 1

Work Calculations on Separate Paper
Answers Given on Next Slides

1. A lagoon is 725 feet wide and 725 feet long at the median epth. The operating depth is 4 feet.

   A. What is the surface area in square feet?

   B. What is the surface area in acres?

   C. What is the Operating Volume in gallons.

   D. How many inches would the water level drop if 2,620,000 gallons were discharged?

2. A lift station pump rated at 250 gpm was on for a total of 608 minutes. How much water was pumped in gallons AND in million gallons?

3. What is the detention time in a 15,725,000 gallon lagoon that receives a flow of 0. 45 MGD?

4. If 1,200,000 gallons were discharged from a lagoon and the effluent contained 25 mg/L of suspended solids, how many POUNDS of suspended solids were discharged?

5. What is the organic loading on a 12 acre lagoon that receives a flow of 0.25 MGD with an average BOD concentration of 150 mg/L.

6. A lagoon is 725 feet wide and 725 feet long at the median depth. How many gallons would be contained in one inch?

Practice Problems 1

1. A lagoon is 725 feet wide and 725 feet long at the median depth. The operating depth is 4 feet.

A. What is the surface area in square feet?

Area = Length X Width

Area = 725 ft. X 725 ft.

= 525,625 ft^2

Practice Problems 1

1. A lagoon is 725 feet wide and 725 feet long at the median depth. The operating depth is 4 feet.

B. What is the surface area in acres?

$$1 \text{ Acre} = 43{,}560 \text{ ft}^2$$

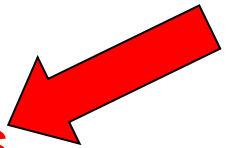
$$\text{Area in Acres} = \frac{\text{Area in ft}^2}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$\frac{525{,}625 \text{ ft}^2}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$= 12 \text{ acre}$$

Practice Problems 1

1. A lagoon is 725 feet wide and 725 feet long at the median depth. The operating depth is 4 feet.



C. What is the Operating Volume in gallons.

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Depth}$$

$$\text{Volume} = \text{Area} \times \text{Depth}$$

$$\text{Volume} = 525{,}625\ \text{ft}^2 \times 4\ \text{ft}$$

$$= 2{,}102{,}500\ \text{ft}^3$$

$$2{,}102{,}500\ \text{ft}^3 \times 7.48\ \text{gallons} / \text{ft}^3$$

$$= 15{,}726{,}700\ \text{gallons}$$

Practice Problems 1

1. A lagoon is 725 feet wide and 725 feet long at the median depth. The operating depth is 4 feet.

D. How many inches would the water level drop if 2,620,000 gallons were discharged?

Operating Volume = 15,726,700 gallons

Depth = 4 feet

$$4 \text{ ft} \times \frac{12 \text{ in}}{\text{ft}} = 48 \text{ inches}$$

$$\frac{\text{gallons}}{\text{inch}} = \frac{15{,}726{,}700 \text{ gallons}}{48 \text{ inches}}$$

$$= 327{,}640 \text{ gal/inch}$$

Practice Problems 1

1. A lagoon is 725 feet wide and 725 feet long at the median depth. The operating depth is 4 feet.

   D. How many inches would the water level drop if 2,620,000 gallons were discharged?

$$\frac{2{,}620{,}000 \text{ gallons}}{327{,}640 \text{ gal/inch}}$$

$$= 8.0 \text{ inches}$$

Practice Problems 1

2. A lift station pump rated at 250 gpm was on for a total of 608 minutes. How much water was pumped in gallons AND in million gallons?

Volume Pumped = Rate X Time

$$\text{Volume Pumped} = 250 \frac{\text{gal}}{\cancel{\text{min}}} \times 608 \cancel{\text{min}}$$

$$= 152{,}000 \text{ gallons}$$

$$\frac{152{,}000 \text{ gallons}}{1{,}000{,}000} = 0.152 \text{ MG}$$

Practice Problems 1

3. What is the detention time in a 15,725,000 gallon lagoon that receives a flow of 0. 45 MGD?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{15{,}725{,}000 \text{ gallons}}{0.45 \text{ MGD}}$$

$$0.45 \text{ MGD} \times 1{,}000{,}000 = 450{,}000 \text{ gal/day}$$

$$\text{Det. Time} = \frac{15{,}725{,}000 \text{ gallons}}{450{,}000 \text{ gallons/day}}$$

= 34.9 Days

Practice Problems 1

4. If 1,200,000 gallons were discharged from a lagoon and the effluent contained 25 mg/L of suspended solids, how many POUNDS of suspended solids were discharged?

POUNDS =

Conc. (mg/L) X Flow (MG) X 8.34 #/gallon

1,200,000 gallons ÷ 1,000,000 = 1.20 MG

POUNDS =

25 mg/L X 1.20 MG X 8.34 #/gal

= 250 Lbs. Suspended Solids

Practice Problems 1

5. What is the organic loading on a 12 acre lagoon that receives a flow of 0.25 MGD with an average BOD concentration of 150 mg/L.

$$\text{Organic Load} = \frac{\text{Pounds BOD/day}}{\text{Acre}}$$

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

= 150 mg/L X 0.25 MGD X 8.34 #/gal

= 312.75 Lbs. BOD/day

$$\text{Organic Load} = \frac{312.75 \text{ Lbs. BOD/day}}{12 \text{ Acre}}$$

= 26.1 # BOD/day/acre

Practice Problems 1

6. A lagoon is 725 feet wide and 725 feet long at the median depth.

How many gallons would be contained in one inch?

$$\text{Volume} = \text{Length X Width X Depth}$$

$$\text{Depth} = 1 \text{ inch}$$

$$\text{Volume} = 725 \text{ ft.} \times 725 \text{ ft.} \times 1 \text{ in.}$$

$$1 \text{ in.} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.0833 \text{ ft.}$$

$$\text{Volume} = 725 \text{ ft.} \times 725 \text{ ft.} \times 0.0833 \text{ ft.}$$

$$= 43{,}785 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3$$

$$= 327{,}512 \text{ gal/inch}$$

Practice Problems 2

Work Calculations on Separate Paper
Answers Given on Next Slides

1. A lagoon is 525 feet wide and 250 feet long at the median depth. The operating depth is 5 feet.

   A. What is the surface area in square feet?
   B. What is the surface area in acres?
   C. What is the Operating Volume in gallons.
   D. How many inches would the water level drop if 245,000 gallons were discharged?

2. A lift station pump rated at 325 gpm was on for a total of 647 minutes. How much water was pumped in gallons AND in million gallons?

3. What is the detention time in a 5,250,000 gallon lagoon that receives a flow of 0. 125 MGD?

4. If 625,000 gallons were discharged from a lagoon and the effluent contained 23 mg/L of suspended solids, how many POUNDS of suspended solids were discharged?

5. What is the organic loading on a 9 acre lagoon that receives a flow of 0.15 MGD with an average BOD concentration of 144 mg/L.

Practice Problems 2

1. **A lagoon is 525 feet wide and 250 feet long at the median depth. The operating depth is 5 feet.**

A. What is the surface area in square feet?

Area = Length X Width

Area = 250 ft. X 525 ft.

= 131,250 ft^2

Practice Problems 2

1. **A lagoon is 525 feet wide and 250 feet long at the median depth. The operating depth is 5 feet.**

B. What is the surface area in acres?

$$1 \text{ Acre} = 43{,}560 \text{ ft}^2$$

$$\text{Area in Acres} = \frac{\text{Area in ft}^2}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$\frac{131{,}250 \text{ ft}^2}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$= 3.0 \text{ acre}$$

Practice Problems 2

1. **A lagoon is 525 feet wide and 250 feet long at the median depth. The operating depth is 5 feet.**

C. What is the Operating Volume in gallons.

Volume = Length X Width X Depth

Volume = Area X Depth

Volume = 131,250 ft^2 X 5 ft

= 656,250 ft^3

656,250 ft^3 X 7.48 gallons / ft^3

= 4,908,750 gallons

Practice Problems 2

1. **A lagoon is 525 feet wide and 250 feet long at the median depth. The operating depth is 5 feet.**

D. How many inches would the water level drop if 245,000 gallons were discharged?

Operating Volume = 4,908,750 gallons

Depth = 5 feet

$$5 \text{ ft} \times \frac{12 \text{ in}}{\text{ft}} = 60 \text{ inches}$$

$$\frac{\text{gallons}}{\text{inch}} = \frac{4{,}908{,}750 \text{ gallons}}{60 \text{ inches}}$$

$$= 81{,}812.5 \text{ gal/inch}$$

Practice Problems 2

1. **A lagoon is 525 feet wide and 250 feet long at the median depth. The operating depth is 5 feet.**

   D. How many inches would the water level drop if 245,000 gallons were discharged?

$$\frac{245{,}000 \text{ gallons}}{81{,}812.5 \text{ gal/inch}}$$

$$= 3.0 \text{ inches}$$

Practice Problems 2

2. A lift station pump rated at 325 gpm was on for a total of 647 minutes. How much water was pumped in gallons AND in million gallons?

Volume Pumped = Rate X Time

$$\text{Volume Pumped} = 325 \frac{\text{gal}}{\cancel{\text{min}}} \times 647 \cancel{\text{min}}$$

$$= 210{,}275 \text{ gallons}$$

$$\frac{210{,}275 \text{ gallons}}{1{,}000{,}000} = 0.21 \text{ MG}$$

Practice Problems 2

3. What is the detention time in a 5,250,000 gallon lagoon that receives a flow of 0.125 MGD?

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}}$$

$$\text{Det. Time} = \frac{5{,}250{,}000 \text{ gallons}}{0.125 \text{ MGD}}$$

$$0.125 \text{ MGD} \times 1{,}000{,}000 = 125{,}000 \text{ gal/day}$$

$$\text{Det. Time} = \frac{5{,}250{,}000 \text{ gallons}}{125{,}000 \text{ gallons/day}}$$

= 42 Days

Practice Problems 2

4. If 625,000 gallons were discharged from a lagoon and the effluent containd 23 mg/L of suspended solids, how many POUNDS of suspended solids were discharged?

POUNDS =

Conc. (mg/L) X Flow (MG) X 8.34 #/gallon

625,000 gallons ÷ 1,000,000 = 0.625 MG

POUNDS =

23 mg/L X 0.625 MG X 8.34 #/gal

= 120 Lbs. Suspended Solids

Practice Problems 2

5. What is the organic loading on a 9 acre lagoon that receives a flow of 0.15 MGD with an average BOD concentration of 144 mg/L.

$$\text{Organic Load} = \frac{\text{Pounds BOD/day}}{\text{Acre}}$$

POUNDS/day =

Conc. (mg/L) X Flow (MGD) X 8.34 pounds/gallon

= 144 mg/L X 0.15 MGD X 8.34 #/gal

= 180 Lbs. BOD/day

$$\text{Organic Load} = \frac{\text{180 Lbs. BOD/day}}{\text{9 Acre}}$$

= 20 # BOD/day/acre

WASTEWATER STABILIZATION LAGOON PROCESS

Prepared by
Michigan Department of Environmental Quality
Operator Training and Certification Unit