14. Stabilzation Ponds

- Stabilization ponds and lagoons are bodies of water which treat wastewater using mainly natural processes including sunlight, algae and microorganisms for treating wastewater
- While ponds are shallow and man-made, lagoons are bodies of water confined within natural boundaries.

14.1 Advantages of ponds

- Cheap to build and operate
- Low maintenance and electrical costs
- Do not require highly trained operational personnel
- Provide treatment that can be equal to some secondary treatment processes and have fewer sludge handling issues.

14.2 Disadvantages of ponds

- Land intensive
- Effluent quality varies with seasonal temperature changes
- Suspended solids levels that can create regulatory problems.
- System upsets almost always result in odor problems and recovery times may be weeks or months.
- Not appropriate for colder climates

14.3 Types of Ponds

14.3.1 Anaerobic Ponds

Anaerobic Ponds

- Typically for treating raw sewage
- These are deep - 10-14 feet treatment ponds which rely primarily on anaerobic bacteria to break down the organic waste.
- Designed for BOD removal.
- High strength wastewater may be treated.
- Organic matter is broken down releasing releasing methane, carbon dioxide and odorous gases including hydrogen sulfide.

- Most of the decomposition is accomplished by acid forming bacteria.
- The pH in these lagoons is usually below 6.5.
- They are total retention and do not have an effluent discharge.
- The anaerobic pond must be de-sludged approximately once every 2 to 5 years
- Organic loading of 200-1000 lbs. BOD_5 per acre per day

14.3.2 Facultative Ponds

- The depth of facultative ponds is about 4-7 feet which is in-between the depths of anaerobic ponds (10-14 feet) and aerobic ponds 3 feet)
- The uper layer of facultative pond is aerobic, and bottom layer is mostly anaerobic.
- Facultative bacteria are responsible for most of the treatment that occurs in these ponds. Facultative bacteria are bacteria which can live under both aerobic and anaerobic conditions.
- The algae that grow in the pond are critical to the successful stabilization of the organic load.
- The algae will take in carbon dioxide (CO_2) and, through photosynthesis, use it to create sugars and release dissolved oxygen (O_2) that is used by the aerobic bacteria. Facultative lagoon levels should always maintain at least 4 feet of water in the pond.
- Typically for secondary treatment - BOD removal
- 15-50 lbs BOD_5 per acre per day.
- Unused CO_2 will react with water to form carbonic acid - which would reduce the pH unless consumed
- Sludge removal need is rare. Sludge can be removed by using a raft-mounted sludge pump or by draining and dewatering the pond and removing the sludge with a front-end loader.

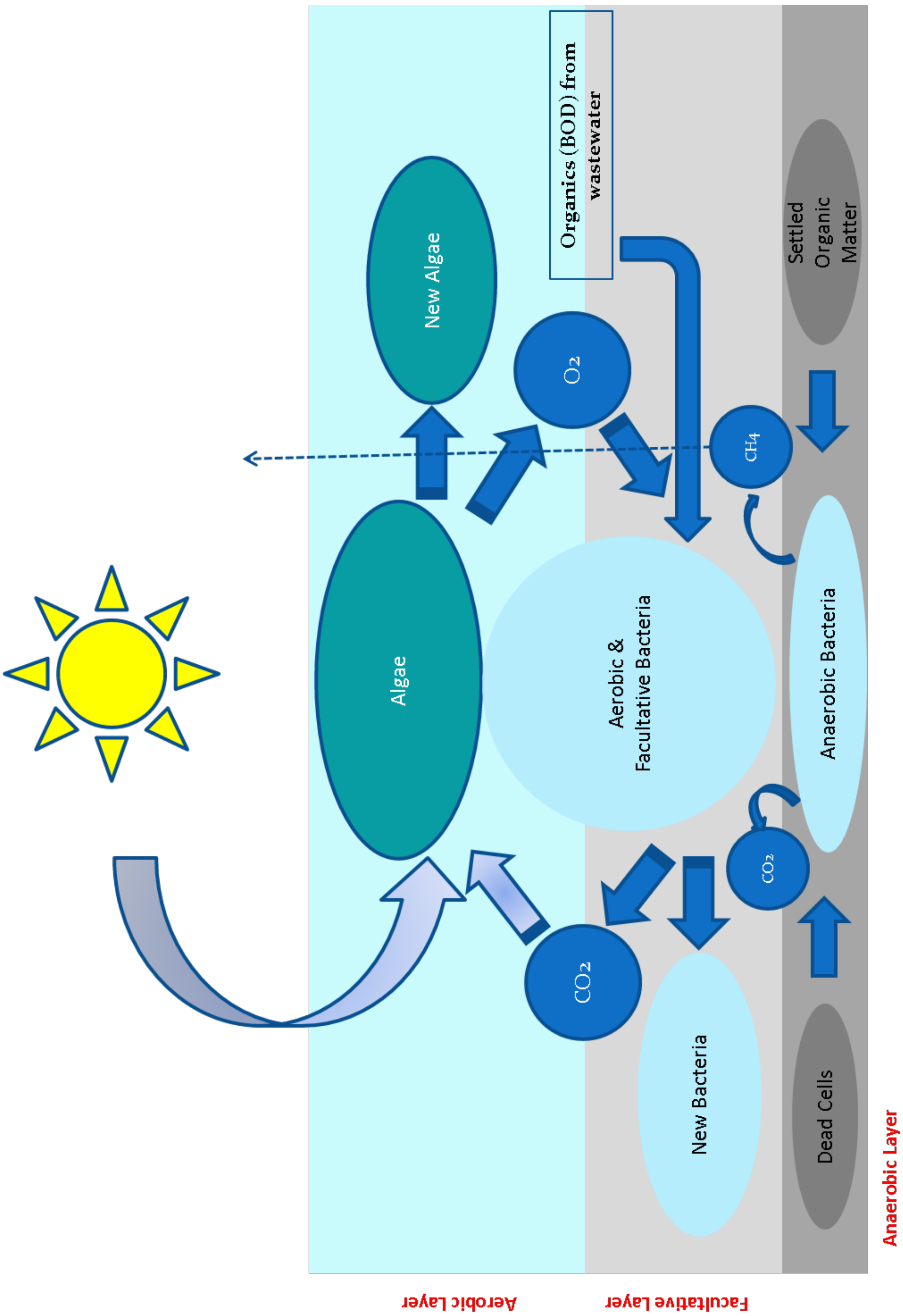
14.3.3 Aerobic Stabilization Ponds

Aerobic stabilization ponds are also known as: maturation, polishing or finishing Pond

- Contain disssolved oxygen throughout entire depth of the pond.
- Treatment is accomplished through the stabilization of organic wastes by aerobic bacteria and algae.
- Typically for tertiary treatment
- Designed for pathogen removal
- Shallow - only about 3 feet deep.
- They are most often the final cells in a multi-staged pond system
- They are also used as polishing ponds for tertiary treatment of trickling filter plant effluent.
- Usually the effluent is directed into a second pond where the sludge can settle
- Their shallow depth allows sunlight to penetrate to the bottom of the pond to encourage algae growth and aerobic conditions throughout the pond
- The low solids loading found in these tertiary treatment applications means that these ponds normally have no sludge zone
- These ponds may be mechanically aerated
- Aerobic polishing ponds are designed for 15-20 pounds BOD/acre/day
- Aerobic ponds are typically designed for pathogen removal
- Aerobic lagoon levels should always maintain at least 18 inches of water in the pond

14.4 Ponds Operations and Maintenance

- Ponds and lagoons are designed as continuous discharge, controlled discharge, or no discharge.
  - In controlled discharge ponds the wastewater is held for long periods of time before discharging.
  - No-discharge ponds the inflow rate needs to be equal or exceed the rates of evaporation and/or percolation.
- Short-circuiting in a pond may be caused by poor design of inlet and outlet piping arrangements or by uncontrolled growth of water weeds.
- Stagnant water will breed mosquitoes and can result in anaerobic conditions developing that can cause odor issues
- Dikes need to be maintained



Facultative pond schematic

- Aquatic plants and weeds must be removed from the water.
- Reeds will create stagnant areas along the edge of the pond and need to be removed
- To start a new pond, two feet of water is typically added prior to fresh starting wastewater feed.
- Sodium nitrate can be used to help recover from an odor-causing upset. The nitrates (NO_3) will provide a source of chemically bound oxygen for the bacteria to use instead of dissolved oxygen.
- Scum control may be required

14.5 Math Problems

14.5.1 Pond Area

Formula: $Pond\ \ Area = Width * Length$

also, $Pond\ \ Area = \frac{Pond\ \ Volume}{Pond\ \ Depth}$

Example Problem:
A pond is 260 ft. long and 80 ft. wide. What is the area of this pond in acres?

Solution:

$$(260*80)ft^2 * \frac{acre}{43,560ft^2} = \boxed{0.48acre}$$

14.5.2 Solids Loading Rate

Formula: $Pond\ \ TSS\ \ loading\ \ rate = \frac{lbs\ \ TSS}{day}$

Example Problem:

The influent flow to a pond is 10,000 gallons/hour with a suspended solids concentration of 142mg/L in the raw wastewater. How many lbs of suspended solids are sent to the pond daily?
Solution:

$$\frac{lbs\ \ TSS}{day} = 10,000\frac{gal}{hr} * \frac{24hrs}{day} * \frac{MG}{1,000,000gal} * 142\frac{mg}{l} * 8.34 = \boxed{284\frac{lbs\ \ TSS}{day}}$$

14.5.3 Organic Loading Rate

Formula: $Pond\ \ organic\ \ loading\ \ rate = \frac{lbs\ \ BOD/day}{Area(acre)}$

Example Problem:

The flow to a pond is 7.2MGD. If the pond diameter is 350 ft and the BOD in the pond influent is 170mg/L, what is the organic loading to this pond in lbs BOD/day/acre?
Solution:

$$Organic\ \ loading = \frac{lbs\ \ BOD\ \ per\ \ day}{area\ \ (acres)} = \frac{(7.2MGD\ \ *\ \ 170mg/l\ \ *\ \ 8.34)}{0.785*350^2 ft^2} * \frac{43,560ft^2}{acre} = \boxed{\frac{4,624lbs\ \ BOD}{day-acre}}$$

14.5.4 Detention time

Formula: $Pond\ \ detention\ \ time = \frac{Volume}{Flow}$

Example Problem:
A 40 acre wastewater treatment pond receives a flow of 0.6 MGD. If the pond is operated at a depth of 4ft. What is the detention time of this pond?
Solution:

$$Pond\ \ detention\ \ time = \frac{Volume}{Flow} = \frac{(40*4)acre-ft}{0.6*10^6\frac{gal}{day}*\frac{ft^3}{7.48gal}*\frac{acre-ft}{43,560ft^3}} = \boxed{87\ \ days}$$

14.5.5 Hydraulic Loading Rate

Formula: $Pond\ \ hydraulic\ \ loading\ \ rate\left[\frac{in}{day}\right] = \frac{Flow}{Area}$

also, $Pond\ \ hydraulic\ \ loading\ \ rate\left[\frac{in}{day}\right] = \frac{Pond\ \ depth\ \ (in)}{Pond\ \ detention\ \ time\ \frac{Volume}{Flow}}$

The second formula above is because:

$$Hydraulic\ \ Loading\ \ (HL) = \frac{Flow}{Area}$$

$$Detention\ \ time\ \ (DT) = \frac{Vol}{Flow} \Longrightarrow Flow = \frac{Vol}{DT}$$

Substituting for flow in the HL formula above:

$$HL = \frac{\frac{Vol}{DT}}{Area}\ \ or\ \ \frac{Vol}{Area*DT} \Longrightarrow \boxed{HL = \frac{Pond\ \ Depth}{DT}}\ \ as\ \ \frac{Vol}{Area} = Pond\ \ Depth$$

Example Problems:

1. Find hydraulic loading in inches/day for a pond given the following:
   - Pond depth = 12ft.
   - Pond volume = 1,400,000ft3
   - Pond flow = 1,000,000gal/day

   Solution:

   $$Pond\ \ hydraulic\ \ loading\ \ rate\left[\frac{in}{day}\right] = \frac{Flow}{Area}$$

   $$\Longrightarrow \frac{1,000,000\frac{gal}{day}*\frac{ft^3}{7.48gal}}{\frac{1,400,000ft^3}{12ft}}*12\frac{in}{ft} = \boxed{13.8\frac{in}{day}}$$

   Note: The area of the pond was found by dividing the volume (1,000,000ft^3) by the pond depth (12ft)

2. Find pond hydraulic loading in inches/day when the depth of the pond is 6 ft. and the detention time is 30 days.

   Solution:

   $$Pond\ \ hydraulic\ \ loading\ \ rate = \frac{Pond\ \ depth\ \ (in)}{Pond\ \ detention\ \ time\ \frac{Volume}{Flow}}$$

   $$\Longrightarrow \frac{6*12\ \ inches}{30\ \ days} = \boxed{\frac{2.4in}{day}}$$