Wisconsin Department of Natural Resources
Wastewater Operator Certification

Introduction to Ponds, Lagoons, and Natural Systems Study Guide

December 2013 Edition

Subclass D

Wisconsin Department of Natural Resources
Bureau of Science Services, Operator Certification Program
PO Box 7921, Madison, WI 53707

http://dnr.wi.gov/

Printed on 12/06/13

Preface

This operator's study guide represents the results of an ambitious program. Operators of wastewater facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for this subclass.

How to use this study guide with references

In preparation for the exams you should:

1. Read all of the key knowledges for each objective.

2. Use the resources listed at the end of the study guide for additional information.

3. Review all key knowledges until you fully understand them and know them by memory.

It is advisable that the operator take classroom or online training in this process before attempting the certification exam.

Choosing a Test Date:

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates is available on the internet at http://dnr.wi.gov, keyword search "operator certification". It can also be found in the annual DNR "Certified Operator" or by contacting your DNR regional operator certification coordinator.

Acknowledgements

This Study Guide is the result of the efforts of the following workgroup individuals:

Todd Weyenberg, Robert E. Lee Inc.
Gary Hanson, AECOM
Dan Tomaro, Wastewater Training Solutions
David Stertz, WDNR-Oshkosh
Jack Saltes, WDNR-Madison
Katherine Robles, WDNR-Madison
Suzan Limberg, WDNR-Madison

Table of Contents

Chapter 1 - Theory and Principles

Section 1.1 - Definitions

1.1.1 Define respiration.

Respiration is the process by which an organism (plant or animal) takes in oxygen and releases carbon dioxide.

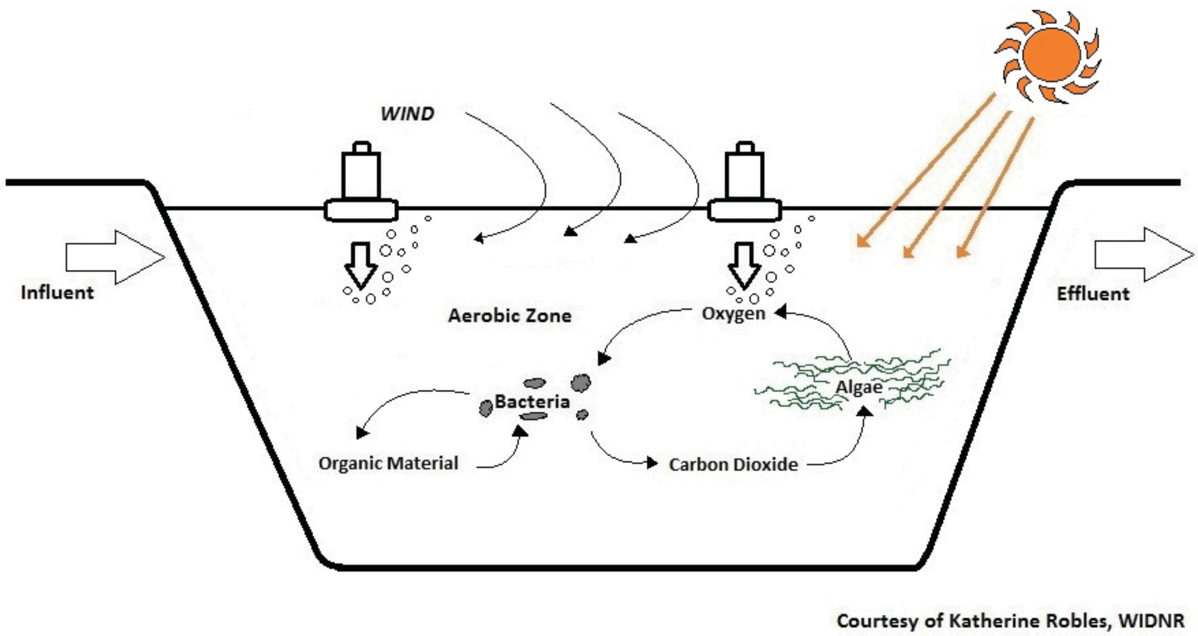
1.1.2 Describe "freeboard" in a pond or lagoon system.

Freeboard is the distance between the normal maximum operating water surface of the pond and the top of the dike. Freeboard is normally 3 feet (meaning the water level should be kept below 3 feet from the dike top).

1.1.3 Describe an aerated lagoon.

An aerated lagoon is a treatment pond that is provided with mechanical aeration that introduces oxygen into the pond in order to promote the biological oxidation of the wastewater. Operators utilize oxygen and microbial action in lagoons to treat the pollutants in the wastewater. Lagoon depths range from 10 to 15 feet.

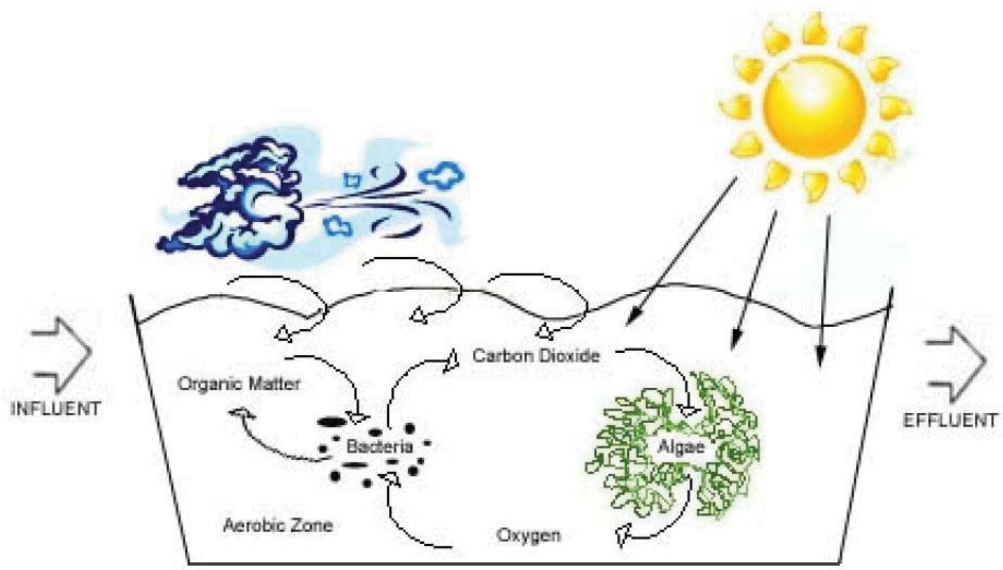
Figure 1.1.3.1



1.1.4 Describe a stabilization pond.

Ponds have historically been used to provide long detention times (greater than 150 days) for wastewater to be stabilized through natural processes. Wastewater is treated by the action of bacteria (both aerobic and anaerobic), algae, other micro and macro organisms, and by the physical process of gravity settling. When properly designed, ponds are capable of providing secondary treatment for both BOD and suspended solids. Pond depths range from 3 to 6 feet.

Figure 1.1.4.1

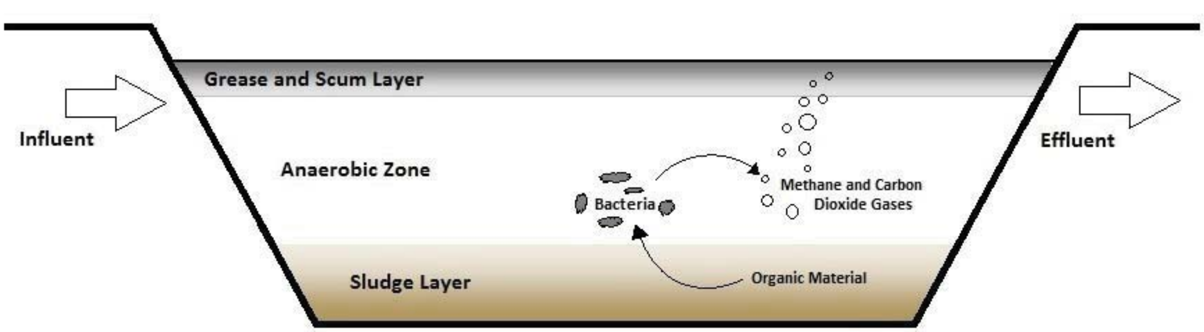


Courtesy of Amy Schmidt WIDNR

1.1.5 Describe an anaerobic pond.

Anaerobic ponds are more than 8 feet deep, have no dissolved oxygen, and use anaerobic bacteria to treat organic material. They provide low cost treatment of high strength organic wastes. They are typically used by industries to pre-treat wastewater, and are followed by aerobic treatment. They usually have a floating cover to contain odors, collect methane gas and retain heat.

Figure 1.1.5.1



Courtesy of Katherine Robles, WIDNR

1.1.6 Describe a spray and drip irrigation system.

Spray and drip irrigation systems are land treatment systems designed to apply wastewater to crops or vegetative cover. Wastewater and the nutrients it contains are taken up by the vegetation for plant growth. Soil microorganisms further treat the wastewater as it moved through the soil. Hydraulic loading rates are based on the crop irrigation requirement and the soil type to which the wastewater is applied.

Figure 1.1.6.1

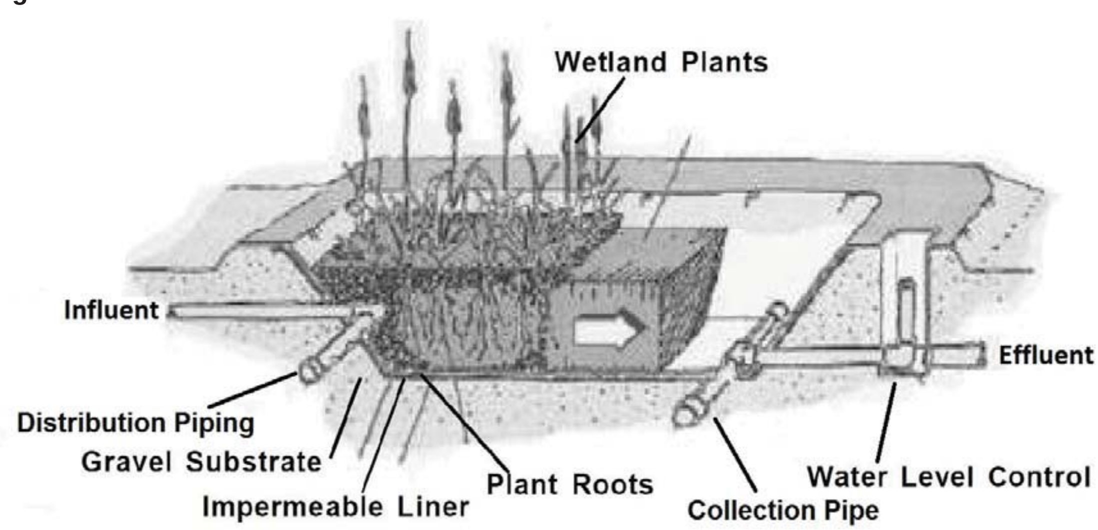
Drip Irrigation **Spray Irrigation**

USGS Photo

1.1.7 Describe constructed wetlands.

Constructed wetlands are a lined wetland designed so that wastewater flows through the system. Soil and vegetation act as a filter, and slow water allowing suspended solids to settle out. Biological uptake and natural processes associated with wetland vegetation, soils and soil microorganisms also remove contaminants.

Figure 1.1.7.1

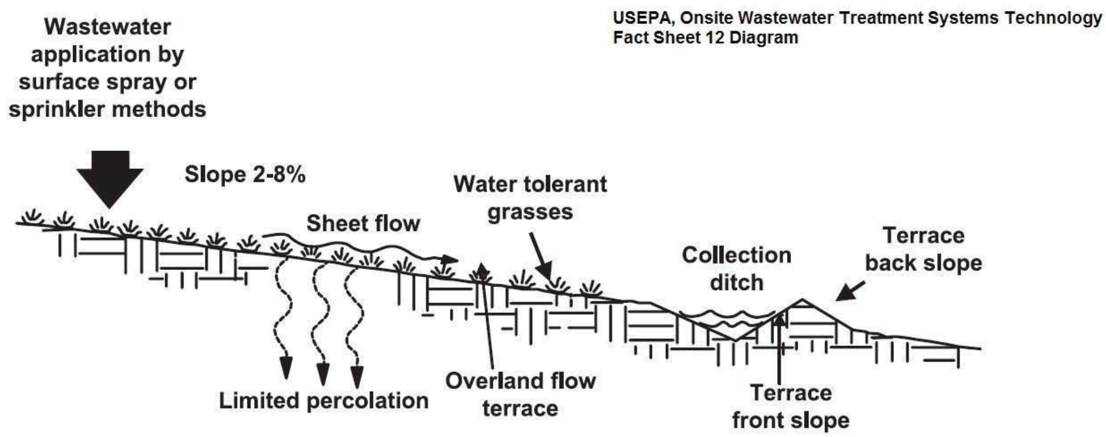


USEPA, Constructed Treatment Wetlands Diagram

1.1.8 Describe overland flow.

Overland flow is a form of land application that treats wastewater by discharging it evenly over a vegetated sloping surface that has fairly impermeable soil. As the wastewater flows over the slope, contaminants and nutrients are absorbed and the water is then recollected at the base of the slope.

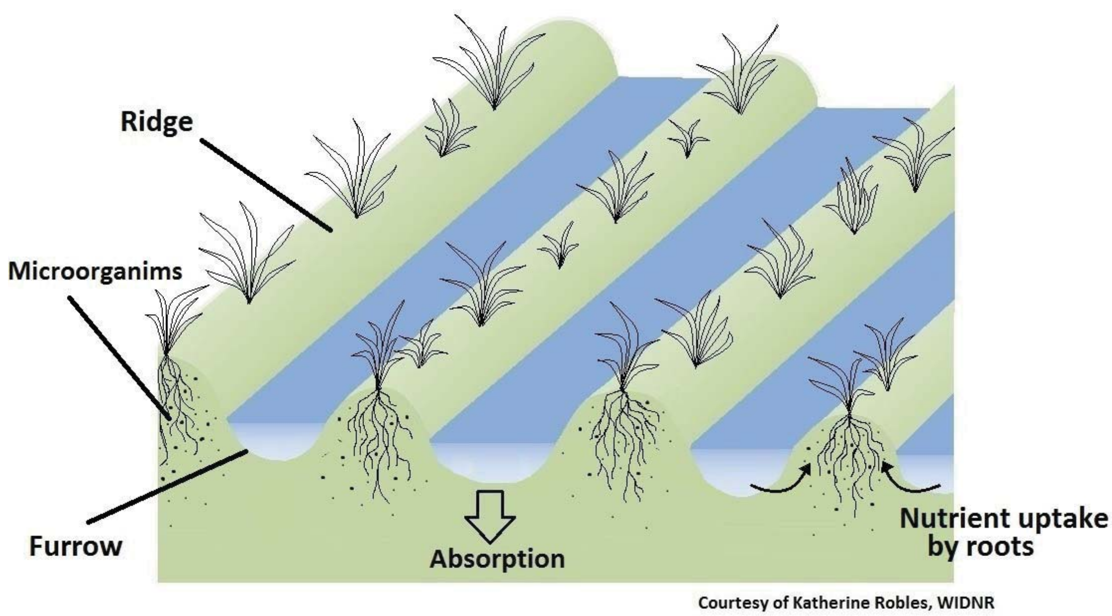
Figure 1.1.8.1



1.1.9 Describe a ridge and furrow system.

Ridge and furrow systems are land treatment systems that allow wastewater to be absorbed into the soil by means of a series of shallow trenches. Wastewater is treated through biodegradation by soil organisms. Water tolerant grasses are grown on the ridges to help absorb water in the summer and to insulate the ground in the winter.

Figure 1.1.9.1



1.1.10 Describe seepage cells.

Seepage cells are a process that uniformly distributes treated wastewater across an unvegetated permeable soil. Suspended solids and organic wastes are removed as they filter through the soil. Typically, treated effluent enters the groundwater or is collected and discharged to surface water. Multiple seepage cells are often used to alternate flow for maintenance purposes.

Figure 1.1.10.1

Barron - Cameron WWTP **Courtesy Jack Saltes, WIDNR**

1.1.11 Describe pond turnover.

Turnover is a term used to describe the natural seasonal (fall and spring) mixing of the water in a lake or pond, creating a uniform temperature of the water column. This movement of water in a pond or lake is due to temperature and density differences between the top and bottom of the water column and wind action. During turnover settled solids can get stirred up, causing odors and raising effluent BOD and TSS.

Section 1.2 - Biological Principles

1.2.1 Describe how stabilization of organic waste material occurs in nature, both in water and in soil.

In nature organic material is used as a food/energy source for bacteria, protozoa, algae and other life forms for their growth and metabolism. Natural treatment systems purify wastewater much like nature. Organic material in the wastewater is absorbed and broken down by microorganisms, green plants, and other life forms.

This process is much slower than mechanical plants. For example, a stabilization pond takes at least 150 days to achieve satisfactory treatment.

1.2.2 Discuss the climatic factors that affect stabilization pond activity.

The biological activity in a stabilization pond is affected by three primary climatic conditions:

A. Light
Sunlight is the driving force for photosynthesis and the production of oxygen in a pond. The depth to which light penetrates the pond will determine the depths to which algae grow and produce oxygen. Solar radiation is highest during the summer. Operating depths are thus between 3-6 feet to allow for sunlight penetration and mixing to effectively occur.

B. Temperature
Temperature affects the rate of bacterial and algal growth/activity. As temperatures rise, activity increases. Treatment is the highest during the summer and lowest during the winter. Ice and snow cover can help insulate a pond from extreme cold temperatures but also limit the sunlight penetration. While cold water has the ability to be saturated with more oxygen, biological activity is reduced during this time because of the cold temperatures.

C. Wind
Wind provides natural mixing to the pond. Some oxygen transfer also occurs at the pond surface. Mixing allows both influent wastewater and oxygen to be dispersed in the shallow water column of the pond. When adequate mixing of the food (BOD), oxygen, algae and bacteria occurs, the entire pond is a natural, active biological treatment facility. To some extent, the operator can ensure good air and wind movement across the pond surface by keeping vegetation controlled in the inside dikes. Vegetation can impede air flow over the pond.

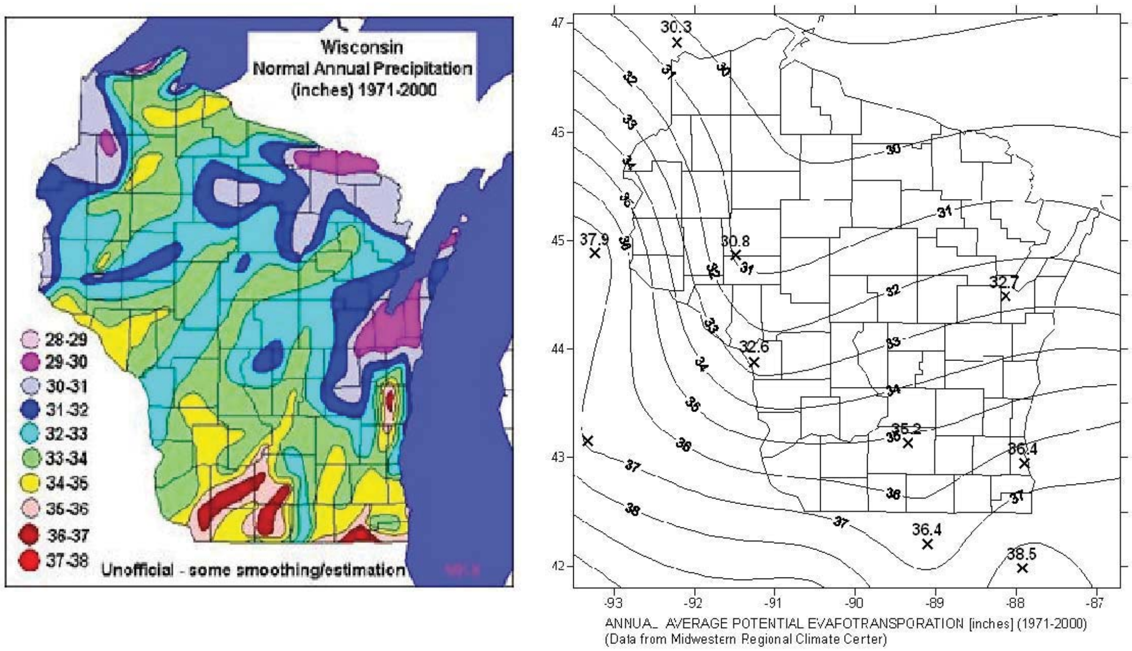
1.2.3 Discuss how precipitation and evaporation affect stabilization pond volume.

A. Precipitation
Severe and large amounts of rain can significantly add water directly and indirectly through inflow and infiltration to a pond. It is thus important that the pond has adequate room and freeboard to accommodate rainfall and not pose any risk of overtopping the dike.

B. Evaporation
Evaporation of water is highest during the summer months when solar radiation and heat is the highest. Days of high humidity will reduce the evaporation rate, while hot, sunny days with low humidity and breezes over the pond surface will result in very high evaporation rates.

In Wisconsin, the annual average precipitation (28-35 inches) closely equals the annual average evaporation (28-35 inches) depending on state location (See Figures 1.2.3.1). For this reason, if leakage is negligible, on an annual basis the amount of wastewater flowing into a pond or lagoon system should approximate the amount that is discharged (total flow in = total flow out). Leakage estimates and concerns can occur based on this knowledge.

Figure 1.2.3.1



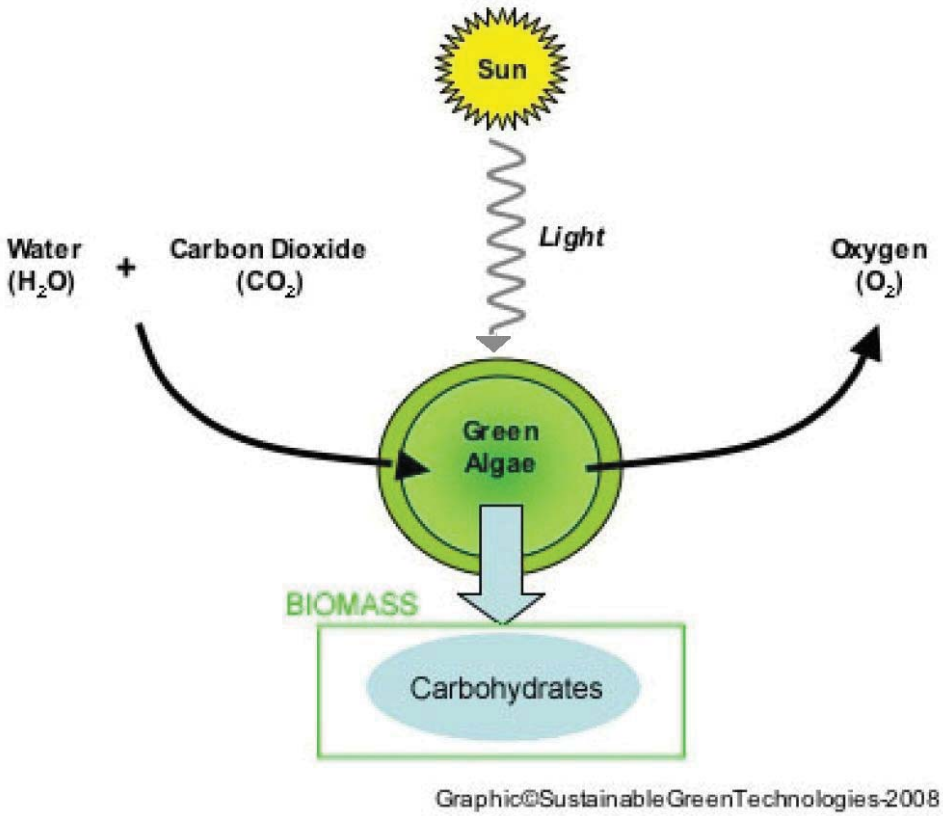
Wisconsin State Climatology Diagram

1.2.4 Discuss what photosynthesis is and how it aids the biological treatment of wastewater in stabilization ponds.

Photosynthesis is a chemical process in nature in which green plants (algae in ponds) that contain chlorophyll use carbon dioxide in the presence of sunlight to produce carbohydrates to grow. In wastewater treatment ponds, photosynthesis releases oxygen as a byproduct, providing oxygen to the bacteria that stabilize the suspended organic material in wastewater. Photosynthesis can be summarized by the equation:

Carbon dioxide + Water => Carbohydrate + Water + Oxygen
$6CO_2 + 12H_2O \Rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

Figure 1.2.4.1



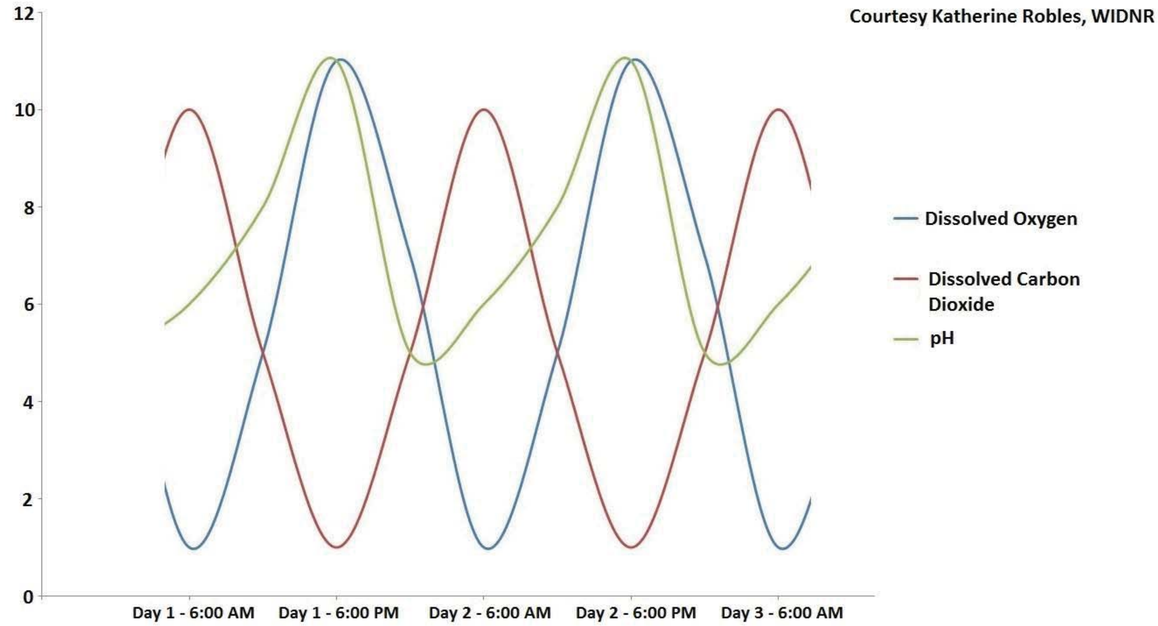
1.2.5 Discuss the relationship between bacteria and algae in a pond system.

In any wastewater pond, treatment is accomplished by a complex community of organisms. They work in an interaction with each other which is mutually beneficial. Algae, like all green growing matter, uses nutrients and carbon dioxide in the presence of sunlight to produce oxygen in a process called photosynthesis. The oxygen produced is used by bacteria to break down organic matter into simpler materials, releasing carbon dioxide to be used by the algae. Breaking down organic material reduces BOD.

1.2.6 Describe how photosynthesis and respiration effect pH, dissolved oxygen and carbon dioxide in a stabilization pond.

When the sun is out, algae uses up dissolved carbon dioxide (CO2) and gives off oxygen (O2) in the process of photosynthesis. At night, algae and microorganisms use dissolved oxygen (DO) and give off CO2 in the process of respiration; this lowers the pH. Thus, pH would be lowest at sunrise. In a non-aerated stabilization pond, this causes a daily swing in the concentration of DO and dissolved CO2.
Dissolved CO2 in the water forms carbonic acid (CO2 + H2O -> H2CO3), which lowers the pH. On long sunny days, most of the CO2 is used up by the algae, therefore there is less carbonic acid and the pH will rise. The pH can reach 11 or 12 in the evening of a sunny summer day.

Figure 1.2.6.1



Section 1.3 - Process Understanding

1.3.1 Discuss the effect turnover can have on a wastewater stabilization pond and effluent quality.

While stabilization ponds are relatively shallow and do not turnover like a lake does, it nevertheless can occur, especially after ice-out in the spring. With the advent of spring, the temperature gradients in the water along with winds create a spring turnover. When this occurs the contents are the ponds are mixed, from top to bottom, and effluent quality may be poor for a few weeks in the spring. Operators should closely monitor their pond at this time and may not want to discharge any effluent when BOD and suspended solids violations may occur.

1.3.2 Discuss the advantages and disadvantages of pond and lagoon systems as compared to mechanical systems.

Advantages:
- Low construction cost
- Low operational cost
- Low energy usage
- Can accept surge loadings
- Low chemical usage
- Fewer mechanical problems
- Easy operation
- No continuous sludge handling

Disadvantages:
- Large land requirements
- Possible groundwater contamination from leakage
- Climatic conditions affect treatment

- Possible suspended solids problem (algae)
- Possible spring odor problems (after ice-out)
- Animal problems (muskrats, turtles, etc.)
- Vegetation problems (rooted weeds, duckweed, algae)
- Periodic, labor intensive and costly sludge removal

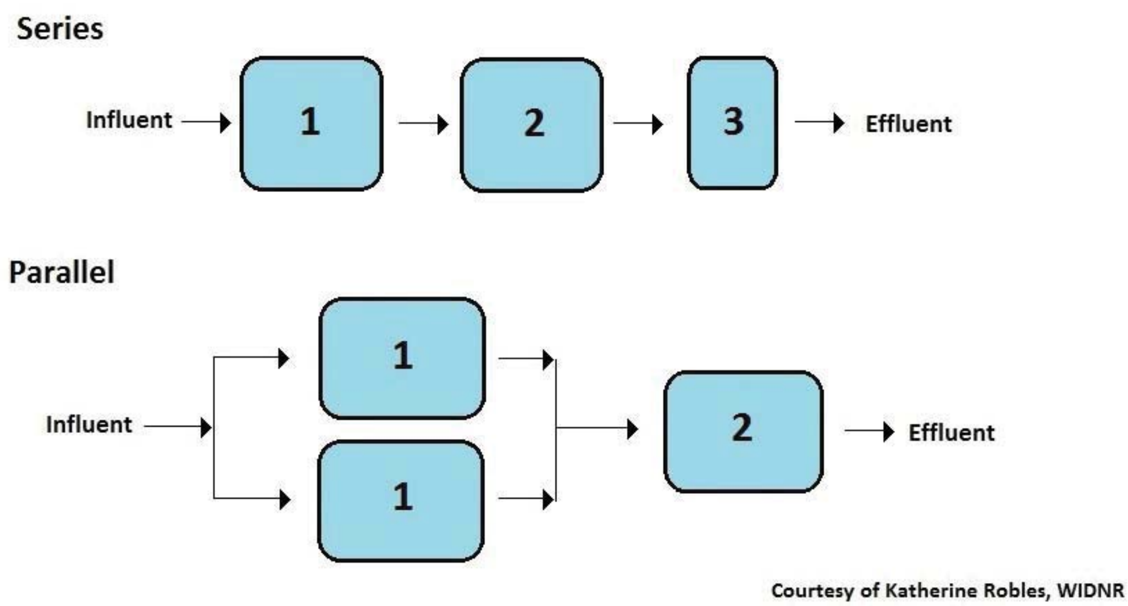
1.3.3 Describe series and parallel modes of pond operation and state conditions when each should be used.

A stabilization pond system is usually composed of a number of individual cells (ponds) and can be operated in several modes.

Series: The flow goes through each cell (pond) in succession (e.g. 1st cell to 2nd cell to 3rd (finishing) cell). This type of flow pattern normally provides the best degree of treatment and minimizes algae in the effluent.

Parallel: The influent flow is divided between two or more primary cells. Parallel operation can be used to evenly distribute high organic loading.

Figure 1.3.3.1



1.3.4 Discuss the following parts of a stabilization pond system.

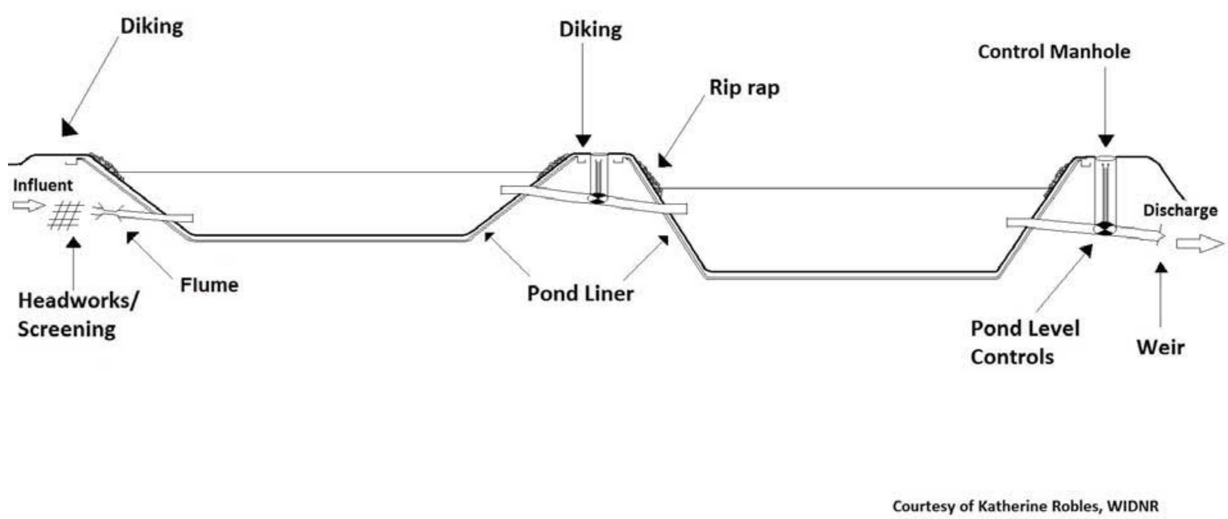
A. Headworks/screening - sometimes provided to remove rags and large objects before wastewater enters the pond.
B. Flow meter/weirs - devices to measure incoming or discharged wastewater flow rates.
C. Dikes - the earthen pond sides which give the pond its shape and depth.
D. Rip rap - rock or stone placed at normal pond operating levels to prevent erosion of the inner slope that could occur from wind actions.
E. Pond Liner- a clay or synthetic liner that keeps wastewater from leaking into the

groundwater.

F. Control Structures:

1. Influent flow
2. Discharge
3. Pond level controls

Figure 1.3.4.1



1.3.5 Discuss the advantages and disadvantages of duckweed.

A limited amount of duckweed can be advantageous to control algae growth and to absorb nutrients. Duckweed can restrict sunlight to a pond to lessen excessive algae growth. However, if too much duckweed is allowed to grow on the surface it can block sunlight. This will cause a reduction in algae growth and a corresponding reduction in dissolved oxygen which can adversely affect treatment. Additionally, the duckweed mat can further affect dissolved oxygen by restricting oxygen transfer from wave action.

1.3.6 Discuss wastewater land treatment concepts.

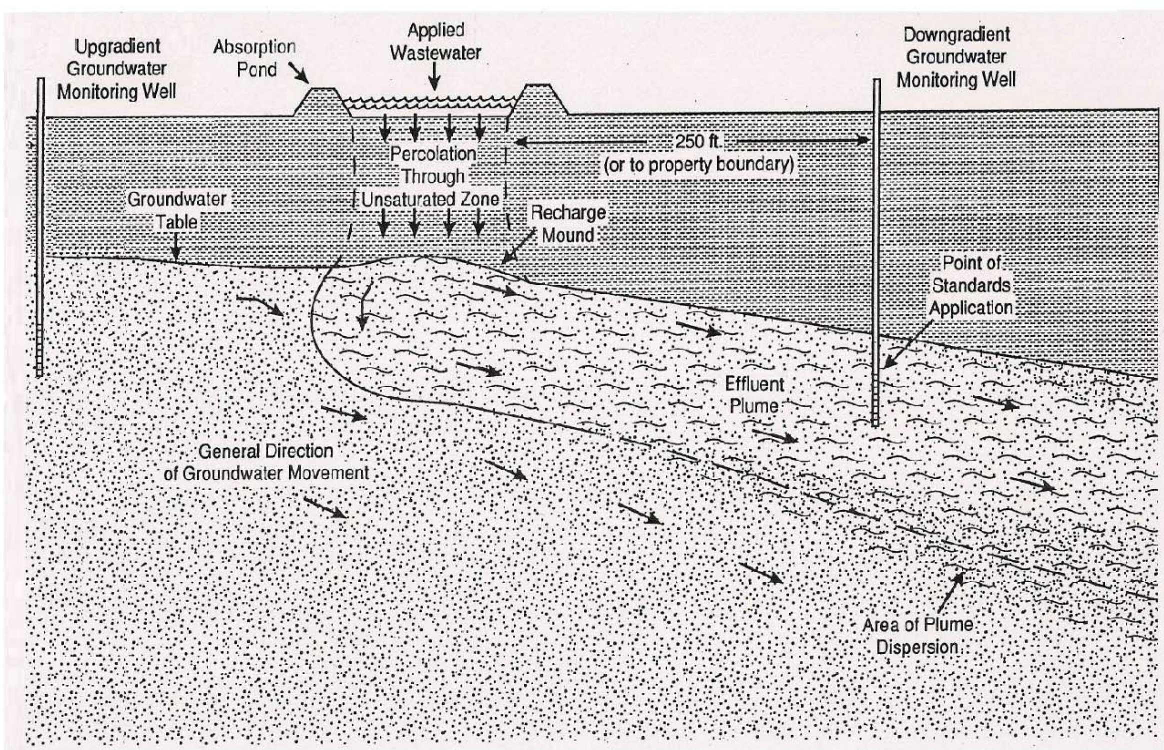
As wastewater moves through soil it is subjected to physical, chemical and microbiological processes of a complex and dynamic nature. The effectiveness of these soil processes in treating wastewater depends on environmental conditions and the unique characteristics of the soil and applied wastewater.

The use of dosing and resting cycle is of principle importance to the operation of absorption ponds such as seepage cells and ridge & furrow systems. When a soil is allowed to drain and dry, air will be drawn into the soil pores creating suitable conditions for the degradation of applied wastes. Drying periods and periodic basin maintenance (scraping or tilling the bottom of the seepage cells) are necessary to restore infiltration capacity and to renew the biological and chemical treatment capabilities of the soil.

Soil type is a fundamental factor affecting both hydraulic and treatment capabilities. Soil particles are generally classified as sand, silt or clay. Sand particles are the largest, therefore sandy soils are very permeable and wastewater seeps away fast. Silt and clay are smaller particles and thus less permeable. Silt and clay are important, however, because they are capable of adsorbing many substances from the applied wastewater. Seeping away slower, pollutants held in the soil profile may subsequently be biodegraded by microbial activity in the soil. The key to successful land treatment performance is to have enough small soil particles and microbes to provide further treatment, but without excessive restriction of the soil hydraulic conductivity.

Treatment in the soil occurs predominantly within the first three feet of the cell bottom. The figure below shows how applied wastewater moves through the upper layers of soil where it eventually reaches the groundwater table. It then enters, recharging the groundwater directly below and travels down gradient in a plume, spreading out as it travels. Groundwater quality standards apply in a down gradient monitoring well located 250 feet from the property boundary. This is known in NR 140 as the Point of Standards application. Between the treatment plant itself and treatment through the soil, groundwater protection can be achieved.

Figure 1.3.6.1



Wisconsin DNR, Land Treatment Concepts and Operational Guidelines for Municipal Absorption Pond Systems Diagram.

1.3.7 Discuss groundwater movement and potential contamination from pond and lagoon systems.

Groundwater typically moves from areas of higher elevation or head to lower elevation or head where it is released into streams, lakes or wetlands. Groundwater moves extremely slow, only a few inches to a few feet per day, depending on the permeability of the soil it is traveling through. Leaking ponds or lagoon systems have the potential to contaminate groundwater. Monitoring wells are used to determine if groundwater contamination is present. Monitoring wells are installed hydraulically downgradient of the pond or lagoon. Another well is located upgradient of the pond or lagoon to determine groundwater quality prior to possible contamination. Monitoring well samples only need to be taken at least once a year due to the slow movement of groundwater.

1.3.8 List some possible consequences of exceeding the design organic loading rate of a pond system.

A. Poor treatment.
B. High effluent BOD.
C. Increase of sludge solids.
D. Potential for objectionable odors.
E. Excessive algae (blue-green filamentous mats).

Chapter 2 - Operation and Maintenance

Section 2.1 - Definitions

2.1.1 Define hydraulic loading rate.

Hydraulic loading rate is the volume of wastewater discharged per day to the land treatment system. It is measured as gal/day.

2.1.2 Define hydraulic application rate.

Hydraulic application rate is the volume of wastewater evenly spread over a designated acreage of the land treatment system divided by a period of time. The rate is calculated by dividing the volume discharged during the waste loading period by the acreage of land loaded and then dividing by the total time in the load/rest cycle (gal/acre/day).

2.1.3 Define load/rest cycle.

Load/rest cycle is a schedule of operation in which a certain volume of waste is loaded on a portion of the treatment system and then that portion is rested. This allows the liquid to drain, the soil to re-aerate, and the soil micro-organisms to break down the waste material

Section 2.2 - Methods

2.2.1 Discuss common methods for controlling stabilization pond water levels.

Pond levels are usually controlled in manholes using boards or valves. In a manhole using boards, boards are inserted or removed in a center wall to raise or lower a pond level. In a manhole using a valve, a valve is turned to raise or lower a pond. All valves in manholes should be exercised on a regular basis to ensure they are operable. Manholes using boards should be inspected regularly and boards replaced if leakage between boards is observed.

Figure 2.2.1.1

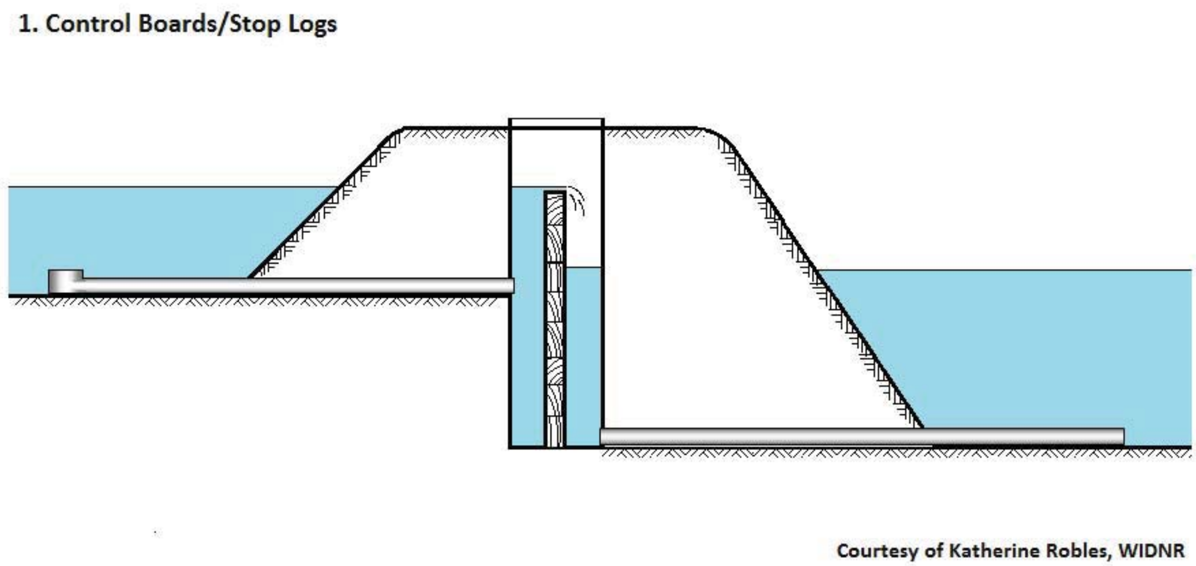
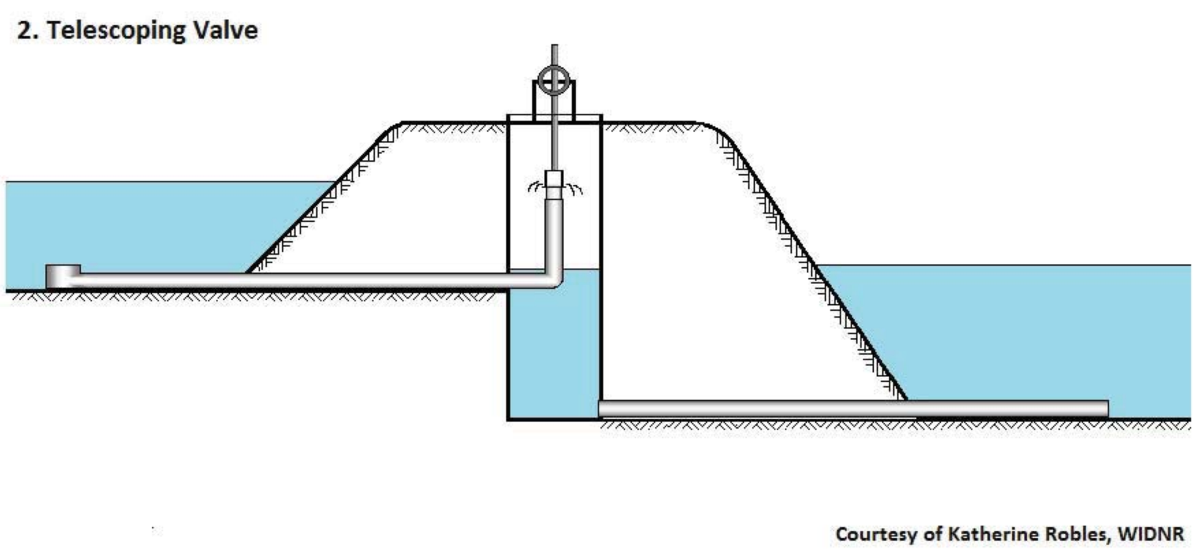


Figure 2.2.1.2



2.2.2 Describe the most common types of algae growing in ponds and lagoons

There are many forms of algae growing in wastewater treatment ponds. The two most common types are green and blue-green algae. Green algae, which give the green color to the ponds, predominate when pond conditions and treatment are good. Blue-green algae are filamentous and indicate poorer pond conditions, such as high organic loading, low dissolved oxygen, low nutrients and warm water conditions. They often form unsightly and odorous mats.

Some of the common forms of green algae are:

Figure 2.2.2.1

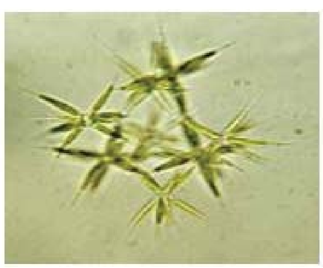
Chlorella

Scenedesmus

Euglena

Chlamydomonas

Actinastrum



Pediastrum

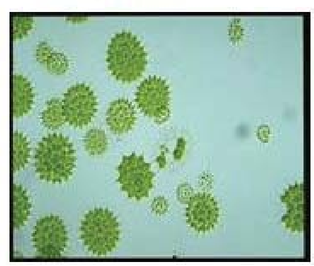
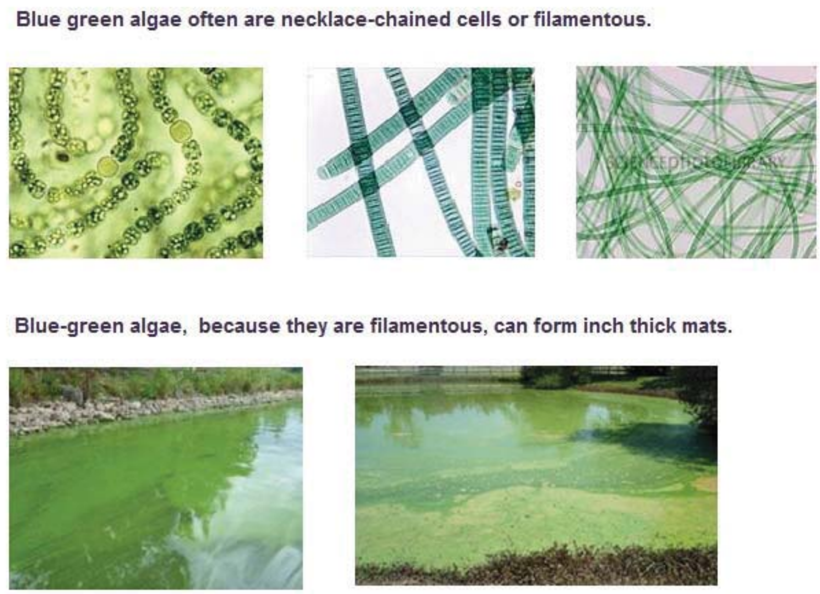


Figure 2.2.2.2



2.2.3 Discuss the significance of algal growth and blooms in stabilization ponds.

The prolific and excessive growth of algae in stabilization ponds can result in heavy algal blooms that cause in a “pea soup” and high effluent total suspended solids. Algae blooms, most common during the summer, occur when the combined environmental conditions are just right for promoting high algal growth: influent food (BOD) and nutrients (especially phosphorus), warm waters and high solar radiation. The discharge of all this algae in the effluent can result in effluent BOD, TSS and phosphorus violations. While many pond systems in Wisconsin have an algae variance of 60 mg/L for their TSS limit, it still may not help if effluent suspended solids are high due to an overabundance of algae. In ponds that have phosphorus limits and add chemicals for removing phosphorus, phosphorus violations may still occur due to the high phosphorus content of the algae themselves.

2.2.4 Discuss what an operator can do to control algae blooms.

First, it is important that the pond system is not overloaded and that it is sized correctly. Stabilization ponds should not be loaded greater than 20 pounds per acre per day and must have a minimum of 150 days of detention time. Second, operating them at the proper water levels (3-6 feet) is important for facultative conditions (aerobic upper layer; anaerobic bottom layer). While algae bloom control strategies are limited, some options are (1) barley straw (in very early spring/summer to reduce algae growth), (2) chemical treatment (alum), (3) storage and holding pond contents (usually not practical), (4) dyes (to reduce sunlight penetration & photosynthesis thus reducing growth) (5) pond covers, especially on the last smaller polishing pond and, (6) ultrasound (if studies prove it a safe and effective method).

2.2.5 Describe the purpose and operation of a fill and draw stabilization pond system.

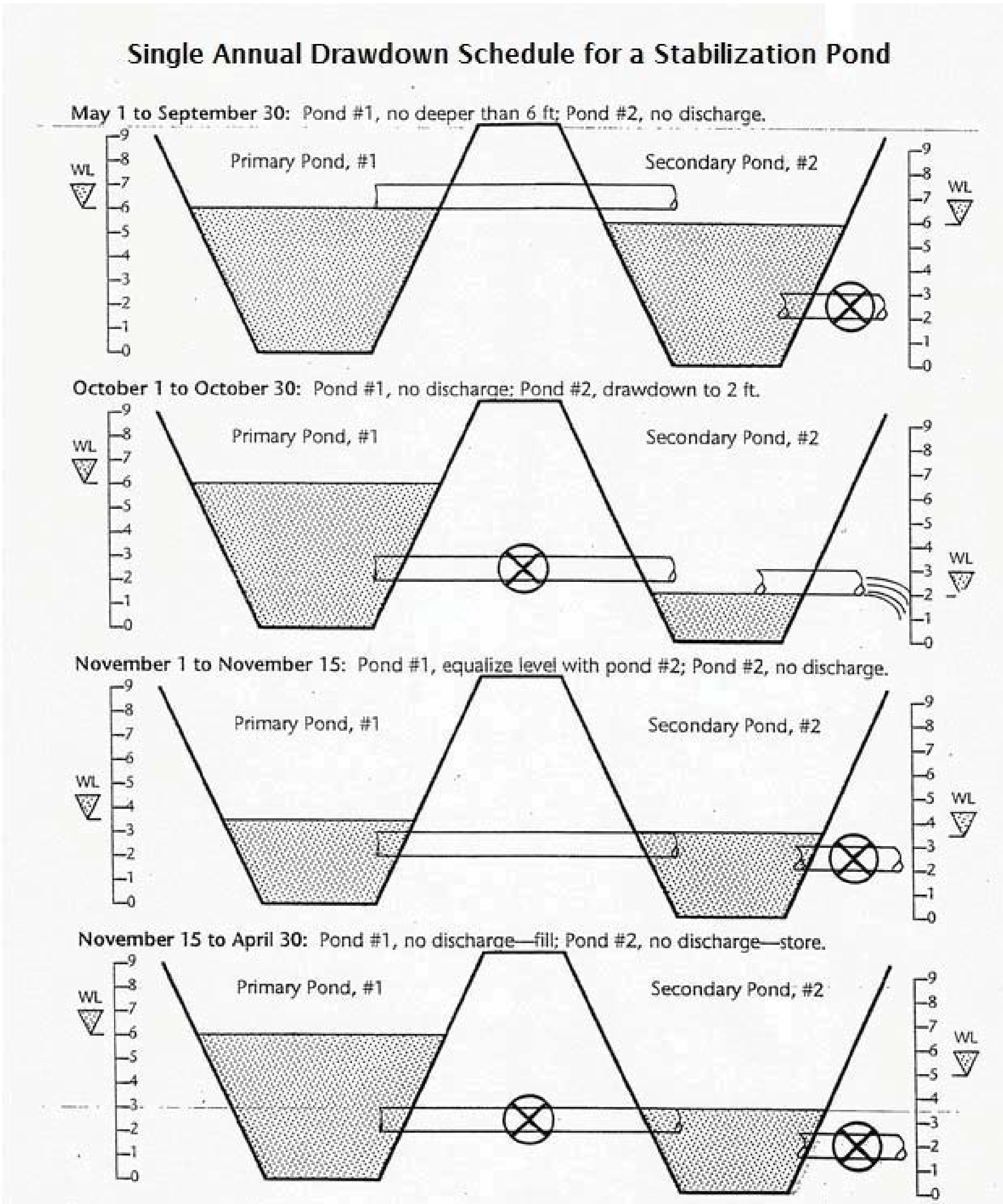
The purpose of a fill and draw mode of pond operation is to allow for the storage (fill) of wastewater when effluent quality may be poor (summer and winter) and for the discharge (draw) of wastewater when effluent quality is good (spring and fall). When not discharging, ponds are filling and receiving treatment. Sampling of the pond and DNR notification is required prior to discharging to ensure permit limits are met.

During spring and fall discharges, receiving streams are also colder and contain more oxygen. A spring discharge can commence almost immediately after ice-out if the BOD levels are acceptable. Algae levels in the pond are low at this time and streams flow high with plenty of oxygen making it a very good discharge period (March - May). While treatment is at its highest in the summer, discharging effluent during the summer depends upon the amount of algae in the pond. Excessive algae or algal blooms, if discharged, can result in effluent violations, especially TSS. Some operators may discharge in the summer only if effluent quality remains below permit limits. As algae concentrations significantly decrease in the fall with the onset of colder weather, operators again discharge while effluent BODs are low. In fact, October-November discharges often can be of the best quality of the year having received a high level of treatment during the summer.

2.2.6 Show a single annual drawdown schedule for a stabilization pond.

To draw down a pond, isolate the pond, if possible, one month before the discharge period. Begin testing to monitor pond contents effluent limited parameters. Send results to the DNR and notify them of the intent to discharge. Calculate what volume will be needed for storage, and discharge at least that amount. Determine from the discharge permit daily discharge volume, and calculate total days required for discharge. Always leave at least one or two feet of treated wastewater in a pond so the wastewater will have an active bacterial concentration. This greatly aids in maintaining oxygen and prevents odors or organic upsets.

Figure 2.2.6.1



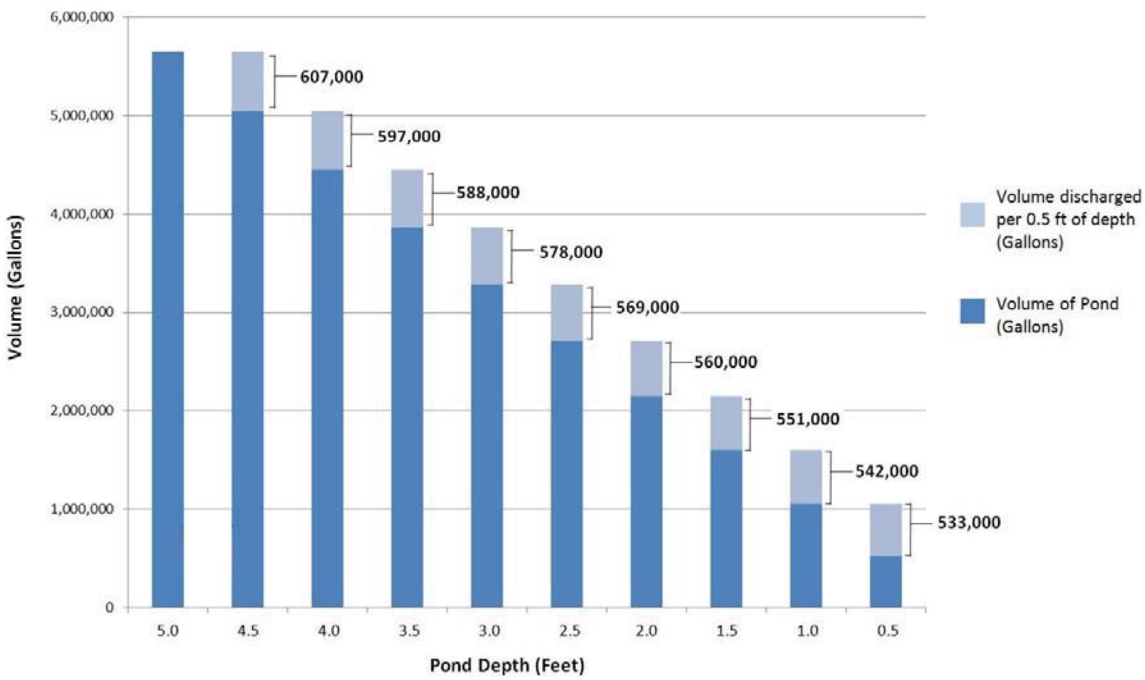
Courtesy of Wisconsin Department of Natural Resources

2.2.7 Show graphically the relationship between drawdown and pond volume during the drawing down of a pond.

Most stabilization ponds are constructed in a trapezoidal shape and therefore when drawing down such a pond from the top down, each foot of water above has a greater volume than the foot below it. Knowing the volume in each foot or half foot of water allows an operator to know how much the pond needs to be lowered to discharge a certain volume of water. By knowing the volume the pond has been emptied allows the operator to know how much storage volume he or she now has for the fill cycle of a fill and draw system. In a fill and draw system, the operator must adequately drawdown the pond system in the fall, allowing for sufficient fill volume during the winter and ensuring at least three feet of freeboard.

The graph below shows two things, the volume of wastewater in every half foot of depth and the total volume of the pond with decreasing depth. Such graphs can be very helpful for both drawing down and filling a pond. By knowing influent flow or effluent flow rates, an operator will then know the time it will take to raise or lower the pond to desired depths.

Figure 2.2.7.1



Courtesy of Katherine Robles, WIDNR

2.2.8 List the reasons why an operator would vary pond levels.

A. Allow more treatment through increased detention time; raising pond levels increases detention time
B. Repair aeration equipment or other structure
C. Repair leaks
D. Control muskrats
E. Control rooted weeds
F. Flood cut cattails
G. Remove sludge
H. Remove pipe blockages

2.2.9 Describe the proper operation of multiple seepage cells.

The best operation for a seepage cell is loading cycles consisting of an application period and drying period. During the drying period soil is able to drain, dry and draw air in, maintaining aerobic conditions in the soil. An application period generally ranges from one to three weeks, while the drying period is one to two times the application period. Before discharging to a seepage cell, the pond contents must be monitored as is required by permit. During discharge, flow to the seepage cell is recorded daily. The flow should be uniformly distributed across the entire seepage cell. Loading rates to seepage cells are up to 90,000 gallons/acre/day.

2.2.10 Describe how to check for efficient aeration of a lagoon.

Monitor lagoon dissolved oxygen, watch surface aeration patterns for changes, read airline pressure gauge, check for changes in effluent BOD, and monitor all aeration equipment. For proper treatment, an aerated lagoon should have an adequate supply of dissolved oxygen. The dissolved oxygen in the surface mixed zone should be at least 2 mg/L.

2.2.11 Describe the effects of seasonal changes on pond treatment efficiency.

Winter: Treatment efficiency decreases in the winter with colder temperatures. Shorter periods of sunlight and ice/snow cover limits the amount of photosynthesis. This may reduce dissolved oxygen in the pond. The cold water also slows down bacterial action, reducing treatment efficiency. If sufficient ice/snow cover is present, the pond may go anaerobic. Emergent weeds and duckweed die-off. During this period, fill and draw ponds are operated by storing wastewater for a spring discharge.

Spring: After ice-out, odors may occur for several days until dissolved oxygen is restored. As temperatures increase, biological activity increases for both bacteria and algae. Treatment efficiency begins to improve with increasing biological activity. After the the pond has stabilized, a spring discharge for fill and draw type systems is usually done prior to active algae growth.

Summer: The long sunny days provide maximum oxygen levels from algae photosynthesis. Warm water temperatures increase bacteria action to provide the best environment for efficient treatment. Operational problems include: controlling rooted emergent weeds, removing duckweed and controlling algae blooms. During this period, fill and draw pond systems are operated by storing wastewater for a fall discharge.

Fall: A transitional time, but in reverse of spring. Water temperatures begin dropping, reducing bacterial activity and photosynthesis as the days get shorter. Treatment efficiencies begin to drop as winter approaches. When the algae levels drop and the BOD stabilizes, fill and draw type systems normally discharge.

2.2.12 Discuss the operating procedures for dealing with a spring thaw.

Ponds will usually fill up fast during spring thaw and levels must be watched so dikes do not overflow. Discharge should be continuous and increased as needed until levels stabilize. Start spring draw down of the ponds if operating on fill and draw. The collection system usually has infiltration, and flow is quite large during the spring thaw. Draw ponds down when streams are cold and flows high.

2.2.13 Discuss the purpose of using rip rap on the inner dike of a lagoon or pond.

Rip rap is used for protecting the inner diking from erosion. Rip rap may consist of 3-5 inch stone placed at normal operating water levels. This size stone prevents erosion due to wave action and is small enough to deter weed growth and burrowing animals. Maintaining rip rap includes keeping it weed free and replenished.

2.2.14 Describe factors that affect the amount of metal salt needed to remove phosphorus in a pond system.

The initial estimate of the metal salt dose needed to remove phosphorus in a pond system can be calculated in the same manner as for an activated sludge system. As with activated sludge, competing reactions will require more metal salt than the theoretical dose. Total phosphorus in a pond includes soluble and particulate phosphorus and phosphorus contained in algal cells. While the metal salt will react with orthophosphate to create an insoluble precipitate, algae and particulates will also settle with precipitate.

2.2.15 Discuss the ways in which phosphorus removal chemicals can be added at a pond or lagoon system.

For continuous dosing, metal salts to remove phosphorus are usually added to the last pond or lagoon where the precipitation reaction and settling can occur. The chemical should be added where good mixing of the chemical with the wastewater can be achieved, such as the upstream manhole prior to the last pond or just before an aerator. For batch dosing of aluminum sulfate (alum), in fill and draw systems, some operators use a small motorboat to apply the alum where the propeller can provide the mixing. Another alternative is to spay alum directly to the surface.

2.2.16 Explain how a pond is "batch treated" using a small motorboat or pontoon type boat.

Alum is typically the phosphorus removal chemical applied to a pond by boat. The boat is fitted with a tank to hold the chemical. The chemical drains by gravity to the propeller area where it is mixed into the pond. The boat travels and applies chemical in a grid work pattern across the entire pond surface. The floc that forms is allowed to settle for 24 - 48 hours and a sample of the treated pond is taken to assure it meets effluent limits before the pond is discharged. This can be an inexpensive and effective method to treat and remove phosphorus from ponds and lagoons. Care must be taken in shallow ponds when boat propellers are used for mixing so as to not rile up the solids settled in the pond or damage the liner.

2.2.17 Discuss the build-up of sludge in lagoons/ponds using chemicals for phosphorus removal.

Solids will accumulate in the pond where precipitates form and settle. The amount of chemical sludge produced is 7.5 mg chemical sludge per mg phosphorus removed for alum, and 10 mg chemical sludge per mg phosphorus removed for iron. Sludge depths should be measured annually and sludge removed as needed to avoid any release of the phosphorus from the settled sludge and organic material.

2.2.18 Discuss management plans for natural land treatment systems.

The department requires management plans for land treatment systems such as ridge and furrow, spray irrigation, and overland flow systems. These plans are for optimizing treatment system performance and achieving compliance. The treatment system must be operated in conformance on pretreatment processes, load and rest schedules, scheduled maintenance, weed control, strategies for adverse weather, and monitoring procedures.

Section 2.3 - Equipment

2.3.1 Describe common aeration equipment used in Wisconsin aerated lagoons.

There are many types and manufacturers of aeration equipment used in aerated lagoons. Some of the most common are diffusers (coarse bubble and fine bubble), static tube helixors, air spargers, floating surface aerators and platform mounted turbines. Subsurface aeration equipment is much less affected by icing issues.

Figure 2.3.1.1

A. STATIC TUBE "HELIXORS"   (Sanitherm Inc. - Pulcon Photo)

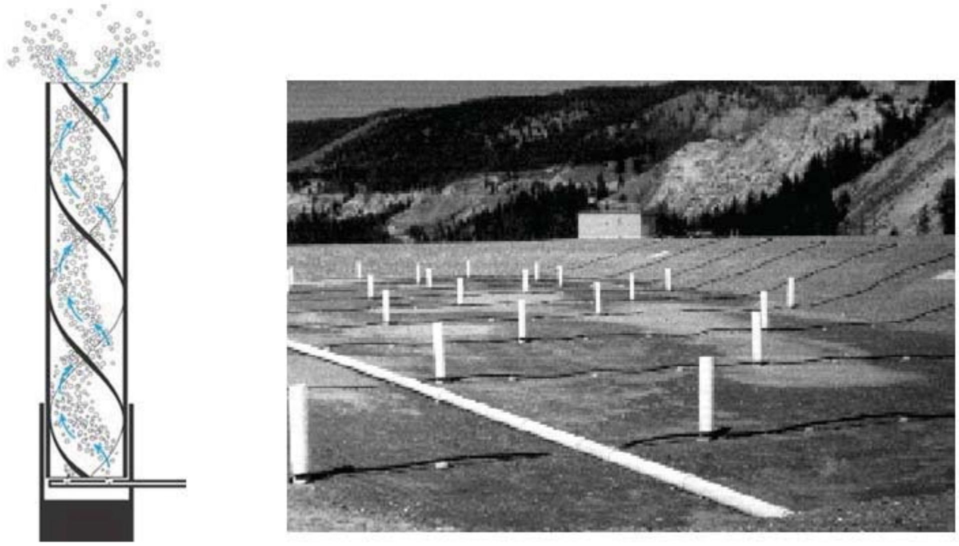


Figure 2.3.1.2

B. SURFACE AERATOR (AIR SPARGER)   (Fuchs Aeration Photo)

Figure 2.3.1.3

C. SURFACE MECHANICAL AERATOR

Figure 2.3.1.4

D. PLATFORM MOUNTED TURBINES (Unitech Water Technologies Pvt. Ltd. Photo)

Figure 2.3.1.5

E. COURSE BUBBLE AND FINE BUBBLE DIFFUSERS (Environmental Dynamics International Photo)

Course Bubble

Fine Bubble

2.3.2 Discuss the purpose of a blower air relief valve in a pond aeration system.

In the event of excess pressure (plugged diffusers or air lines) the pressure relief valve will open to release excess pressure and protect the piping, diffusers, and the blower.

2.3.3 Describe the meaning of blower air pressure gauge readings.

The normal operating discharge pressure from a blower is 5 to 14 psi. High readings of an air gauge are caused by plugged airline, orifices, diffusers, or ice cap. Low readings of an air gauge could be caused by a faulty blower, an air leak, or clogged blower inlet filter. In either case, there is a possibility that the blower could overheat, causing damage to the unit. A hot blower should be shut-down and corrective action taken.

2.3.4 Describe how pond depth and bubble size affect aeration efficiency.

The deeper the pond, the longer the contact time before the bubbles reach the surface. The smaller the bubbles are the more contact surface between the air and water, which increases the transfer rate.

Section 2.4 - Preventative Maintenance

2.4.1 List common maintenance considerations for a diffused aeration system.

A. Centrifugal Blowers

1. Unusual noise or vibrations
2. Lubrication of blowers and motors
3. Check and lubricate couplings
4. Check discharge pressure and temperature
5. Check filters and obstructions
6. Check amperage meter

B. Positive Displacement Blowers
1. Unusual noise or vibrations
2. Lubrication of blowers and motors
3. Check and lubricate couplings
4. Check and exercise pressure relief valve
5. Check discharge pressure and temperature
6. Check filters and obstructions
7. Check blower seals
8. Check drive belt alignment and tension

An operator should refer to the operation and maintenance manual for all required maintenance. All maintenance and repairs should be documented.

2.4.2 List components of a maintenance recordkeeping system

Typical equipment at ponds and lagoons needing maintenance are blowers, aerators, piping, pumps, manholes, valves, mowing, weed control, flow metering and sampling equipment. Maintenance recordkeeping involves the use of various formats to record performed maintenance and repairs. Examples include a folder filing system, a card system or computers with appropriate software.

Two major components of a good maintenance recordkeeping system are a History of Repairs for major equipment items and a preventative maintenance program that schedules the interval frequency for routine maintenance tasks, such as lubrications and other tasks, for each piece of equipment. Preventative maintenance that is to be performed at a treatment facility can be found in the plant's Operation and Maintenance (O&M) Manual. A regular preventative maintenance program reduces major breakdowns, unexpected repairs, and excessive weed overgrowth

2.4.3 List the most common maintenance tasks associated with pond systems.

A. Weed control - cattails and other rooted aquatic plants.
B. Algae control - blue-green and associated floating algae mats, algal blooms.
C. Burrowing animals - muskrats and turtles.
D. Duckweed control and removal.
E. Floating sludge mats.
F. Dike vegetation - mowing and removing woody plants.
G. Dike erosion - rip rap and proper vegetation.
H. Fence maintenance to restrict access.
I. Mechanical equipment - pumps, blowers etc.
J. Valves – exercise valves regularly.
K. Manholes – Hydrogen sulfide corrosion, especially influent manholes.

2.4.4 Discuss the maintenance of seepage cells.

Control weeds by tilling the soil. Keep level. Seepage cells should be tilled on a regular basis so that excessive vegetation growth does not occur. If weed growth becomes excessive it may need to be mowed and removed before tilling. Seepage cell maintenance involves aerating the soil crust which builds-up at the soil-air interface. This crust impedes water and oxygen percolation into the soil. Any suitable tilling equipment can be used. Tilling 6" to 12" helps control weed growth which proliferates on the surface. Avoid unnecessary soil compaction.

2.4.5 Describe the ways to control aquatic vegetation.

Rooted weeds can be controlled by:
A. Physical removal of new growth by hand.
B. Mowing with a sickle bar after ice has formed.
C. Increasing the water level to reduce light penetration to stop photosynthesis.
D. Lowering the water level and burning the weeds.

2.4.6 Discuss how to deal with floating mats.

Floating mats on pond systems are caused by floating sludge, blue-green algae, or oil and grease; the most common are sludge and algae mats. Mats can cause odor problems. It can be corrected by trying to break-up the sludge or algae mats and allowing them to settle to the bottom. If this does not work, it will be necessary to rake them out and dispose of them. If oil and grease are a problem, the source of this material should be eliminated through a grease control program.

2.4.7 Describe how cattails can be controlled without chemicals.

Cattails can establish themselves in the shallow water and soft bottoms along the dikes. Cattails have extensive root systems and can spread by rhizomes forming large interconnected stands. They can also spread by wind-dispersed seeds so controlling them early as they try to establish themselves in the pond is desirable before they become large colonies and a labor intensive task. When cattails are young and just starting to grow, manually pulling them out is a very effective preventative maintenance task to regularly do.

If left to mature and spread into colonies along the pond banks, then “drowning” them can be an effective method. There are two ways to do this seasonally. During warm weather, a pond with mature cattail stands in them can be lowered if possible, the cattails stalks cut and then the water raised to 2-3 feet over them will ‘drown” and kill them. If lowering the pond is not possible, a boat mounted weed cutter can be used to cut them below the water surface. An easier cutting method may be during the winter. In the fall, during a fall discharge, the pond with cattail stands is lowered and left as low as possible for the winter. Once ice covers the ponds, an operator can then walk to the cattails and easily cut them at the ice surface. In the spring, the water is allowed to raise 2-3 feet over the cut stems with the same drowning result. If the cattails problem is excessive, this method may have to be repeated over a couple of winters as the cattails are reduced each summer until they completely disappear from the pond.

Figure 2.4.7.1

2.4.8 Discuss the use of chemicals for controlling vegetation both in and around the pond.

The use of chemicals to control vegetation in a pond should be limited. Due to toxicity concerns, manual or mechanical methods of control are preferred. Chemical vegetation control should only be used as a last resort in a pond and needs DNR approval.

When using chemicals to control vegetation on diking and around the pond, products such as Round Up or equivalent can be used. Do not overspray into the pond and follow all safety precautions and use recommendations when handling chemicals.

2.4.9 Identify types of dike vegetation, and how to control grass and other plant growths.

It is very important that dikes have a protective grass cover to prevent erosion from runoff and wave action. The grasses used should be fast growing, spreading, with shallow, but dense root systems (e.g. rye, brome and quack). Mowing should be done periodically so dikes can be observed and to reduce breeding areas for insects.

Tree and shrubs should not be allowed to grow on dikes as their root structure could cause dike leakage, damage to the pond seal, or structural failure to the dike. All woody plants should be removed by pulling or mowing, and in the event they become established, it will be necessary to use brushing methods (e.g. pruning, chain saw, brush saw, weed whacker, etc.).

2.4.10 Discuss the solids build up in stabilization ponds.

Over time, sewage solids settle and can start to build up on the pond bottoms, especially in the first stabilization pond. Measuring solids deposition should start at about 10 years of operation or the last sludge removal. Solids in a pond or lagoon can be measured using a sludge depth finder such as a Sludge Judge from a row boat. Using a surface grid, sludge depth measurements should be taken every so many feet, perhaps every 50 feet, starting near the influent pipe and recorded on the grid.

Many ponds eventually, after about 15-20 years, need to have solids mechanically removed.

Accumulated solids reduce the detention time of the pond, which can reduce treatment. For example, every foot of a 3 acre, 5 foot deep pond contains about 1 MG or 50 days of detention time. Every foot of sludge thus reduces the detention time by 50 days (20%); two feet by 100 days (40%). Treatment will ultimately be effected. If sludge starts to accumulate to 1 ½ -2 feet in much of the pond, removal should start to be considered and budgeted. Most solids will deposit within a certain radius of the influent pipe, causing a “volcano” type build-up effect. Sometimes solids may only need to be removed in the near vicinity of the influent sewage pipe to ensure solids do not affect the influent sewage flow rate.

Sludge removal, when necessary, should be planned and done through a consultant and contractor. It is extremely important that the equipment and methods used do not damage the pond liner and diking. The sludge removal plan must be sent to and approved by WDNR. The disposal of pond/lagoon sludge must meet all sludge sampling, reporting and land application requirements of the WPDES permit and code requirements.

2.4.11 Discuss the operation and maintenance needs of an overland flow treatment system.

Daily inspection of collection ditch integrity should be performed. If breeched, runoff collection ditches need to be restored. The overland flow terrace should be inspected for ponding or channeling. If these conditions exist, the terrace is taken off line, filled and reseeded. The vegetation should be mowed or harvested as needed.

2.4.12 List the operation and maintenance needs of a spray irrigation treatment system.

A. Pumps: lubrication, check seals, record pressure
B. Drive for the center pivot sprayer: lubricate gears, check tire pressure and tread
C. Nozzles: keep clean, unplug as needed
D. General: drain system completely before freezing weather

2.4.13 List the operation and maintenance needs of a ridge and furrow system.

A. Remove grasses at beginning of or prior to growing season and at least one additional time during the growing season to maximize nutrient uptake. Prior to growing season grasses may be burned.
B. Alternate loadings between cells to allow cells to rest prior to recharge.
C. Ensure adequate rest period to allow ridge soil to become unsaturated and aerobic.
D. Visually evaluate ridge and furrow system to verify uniform loading and verify no wastewater runoff.
E. Maintain pumps by lubrication, check seals, record pressure and run time.

Chapter 3 - Monitoring, Process Control, and Troubleshooting

Section 3.1 - Definitions

3.1.1 Define Preventive Action Limit (PAL).

Preventive action limits are a groundwater quality standard that serves two main purposes. First, PAL’s set limits to prevent contamination. PAL’s also serve as an indicator that remedial actions or a regulatory response may be necessary. PAL’s are a lesser concentration than the enforcement standard for a substance, with the intention of giving permitees time to take preventive action so that the enforcement standard is not exceeded.

3.1.2 Define Enforcement Standard (ES).

Enforcement standards are groundwater quality standards set for substances that pose a risk to public health or welfare. When a substance is detected in the groundwater in concentrations equal to or greater than its enforcement standard, the activity, practice or facility that is the source of the substance is subject to enforcement action. Corrective action is required to bring a facility back into compliance.

3.1.3 Define Point of Standards Application.

Point of standards application means the specific location, depth or distance from a facility, activity or practice at which the concentration of a substance in groundwater is measured for purposes of determining whether a preventive action limit or an enforcement standard has been attained or exceeded.

Section 3.2 - Sampling and Testing

3.2.1 Describe typical WPDES permit monitoring requirements for a pond/lagoon system.

The WPDES permit for a pond/lagoon system will specify the types and frequency of influent and effluent sampling from a pond or lagoon system. Influent and effluent are always sampled for BOD and suspended solids. Other effluent parameters may also be required such as pH, ammonia, total nitrogen, phosphorus and chlorides depending on the receiving water (surface water or groundwater) and the effluent limits in the WPDES permit. Sampling results are entered on Electronic Discharge Monitoring Reports (eDMR).

The following Discharge Monitoring Report shows the influent and effluent flow monitoring and sampling required for a stabilization pond system discharging to seepage cells.

Figure 3.2.1.1

Wastewater Discharge Monitoring Long Report

Facility Name:
Contact Address:

Facility Contact:
Phone Number:
Reporting Period: 04/01/2013 - 04/30/2013
Form Due Date: 05/15/2013
Permit Number:

For DNR Use Only

Date Received:
DOC:
FIN:
FID:
Region:
Permit Drafter:
Reviewer:
Office:

	Sample Point	701	701	701	701	701
	Description	INFLUENT	INFLUENT	INFLUENT	INFLUENT	INFLUENT
	Parameter	211	66	457	335	337
	Description	Flow Rate	BOD5, Total	Suspended Solids, Total	Nitrogen, Total Kjeldahl	Nitrogen, Organic Total
	Units	MGD	mg/L	mg/L	mg/L	mg/L
	Sample Type	CONTINUOUS	GRAB	GRAB	GRAB	CALCULATED
	Frequency	CONTINUOUS	2/MONTH	2/MONTH	MONTHLY	MONTHLY
Sample Results	Day 1	0.063				
	2	0.060				
	3	0.065				
	4	0.055				
	5	0.059				
	6	0.061				
	7	0.065				
	8	0.066	110	100	24	28
	9	0.075				
	10	0.090				
	11	0.100				
	12	0.100				
	13	0.057				
	14	0.056				
	15	0.065				
	16	0.075				
	17	0.070				
	18	0.120				
	19	0.080				
	20	0.070				
	21	0.065				
	22	0.080				
	23	0.054				
	24	0.053				
	25	0.055				
	26	0.065				
	27	0.065				
	28	0.062				
	29	0.064	230	260		
	30	0.061				
	31					

	Sample Point	701	002	002	002	002
	Description	INFLUENT	EFFLUENT (SEEPAGE CELL)	EFFLUENT (SEEPAGE CELL)	EFFLUENT (SEEPAGE CELL)	EFFLUENT (SEEPAGE CELL)
	Parameter	789	211	66	457	377
	Description	Nitrogen, Ammonia (NH_3-N) Total	Flow Rate	BOD5, Total	Suspended Solids, Total	pH Field
	Units	mg/L	MGD	mg/L	mg/L	su
	Sample Type	GRAB	CONTINUOUS	GRAB	GRAB	GRAB
	Frequency	MONTHLY	CONTINUOUS	2/MONTH	2/MONTH	2/MONTH
Sample Results	Day 1		0.090			
	2		0.090			
	3		0.090			
	4		0.090			
	5		0.090			
	6		0.090			
	7		0.090			
	8	17	0.090	20	33	8.89
	9		0.090			
	10		0.090			
	11		0.090			
	12					
	13					
	14		0.090			
	15		0.090			
	16		0.090			
	17		0.090			
	18		0.090			
	19		0.089			
	20		0.090			
	21		0.090			
	22		0.090			
	23		0.090			
	24		0.090			
	25		0.090			
	26		0.090			
	27		0.090			
	28		0.090			
	29		0.090	11	26	8.97
	30		0.090			
	31					

	Sample Point	701	701	701	701	701
	Description	INFLUENT	INFLUENT	INFLUENT	INFLUENT	INFLUENT
	Parameter	211	66	457	335	337
	Description	Flow Rate	BOD5, Total	Suspended Solids, Total	Nitrogen, Total Kjeldahl	Nitrogen, Organic Total
	Units	MGD	mg/L	mg/L	mg/L	mg/L
Summary Values	Monthly Avg	0.0692	170	180	24	28
	Daily Max	0.12	230	260	24	28
	Daily Min	0.053	110	100	24	28
Limit(s) in Effect	Monthly Avg					
QA/QC Information	LOD					
	LOQ					
	QC Exceedance	N	N	N	N	N
	Lab Certification					

	Sample Point	701	002	002	002	002
	Description	INFLUENT	EFFLUENT (SEEPAGE CELL)	EFFLUENT (SEEPAGE CELL)	EFFLUENT (SEEPAGE CELL)	EFFLUENT (SEEPAGE CELL)
	Parameter	789	211	66	457	377
	Description	Nitrogen, Ammonia (NH_3-N) Total	Flow Rate	BOD5, Total	Suspended Solids, Total	pH Field
	Units	mg/L	MGD	mg/L	mg/L	su
Summary Values	Monthly Avg	17	0.089964286	15.5	29.5	8.93
	Daily Max	17	0.09	20	33	8.97
	Daily Min	17	0.089	11	26	8.89
Limit(s) in Effect	Monthly Avg			50 0		
QA/QC Information	LOD	0.13				
	LOQ	0.25				
	QC Exceedance	N	N	N	N	N
	Lab Certification					

3.2.2 Describe flow monitoring and taking samples from a pond/lagoon system.

Sampling and flow monitoring requirements are contained in the WPDES permit. Influent and effluent flow metering is often required so that influent and effluent volumes are known and also so that leakage estimations can be made (see key knowledge 3.3.3). For remote fill and draw pond systems without nearby power, portable battery or solar powered flow meters can be used for effluent flow metering during discharge periods.

Samples of raw wastewater should be taken where it enters the pond system or at the lift station that pumps the wastewater to it. Flow proportional samples are always preferred over grab samples and will be required in the permit if that capability exists or if power can be economically extended to the site.

In a fill and draw pond system, the pond has to be sampled prior to discharging to ensure it will meet effluent limits. It is important that this sampling be representative of the pond contents that are to be discharged. Multiple samples should be collected and then mixed together prior to laboratory analysis. One commonly used method is to collect a pond sample from the four corners of the pond as far as a sampling cup and long pole can be safely extended from the shore (6-10 feet) and below the surface of the water. The four samples of equal volume should be mixed together and then tested.

Samples of final effluent should be taken where the treated wastewater leaves the treatment system. The sample should be at a well-mixed representative location. Again, flow proportional samples are always preferred over grab samples and will be required in the permit if that capability exists.

3.2.3 Explain how the following samples should be collected and preserved for analysis:

A. BOD and TSS
B. Fecal Coliform
C. ph and Dissolved Oxygen
D. Phosphorus
E. Ammonia

A. BOD and TSS: The most representative influent and effluent BOD /TSS sample is collected using a 24-hour flow-proportional sampler. When electrical power is not available, a grab sample can be collected. Influent samples to a pond or lagoon site usually involve composite sampling because of power availability. Effluent composite samples are preferred at pond sites, but when electrical power is not available or possible, a grab sample is taken. The WPDES permit will specify the type and frequency of sample collection. A BOD and TSS must be kept cool (to 6°C or less) and sent in to a lab for analysis within 48 hours.

B. Phosphorus and Ammonia
The most representative samples collected for ammonia and phosphorus are 24 hour flow proportional samples. If a portable sampler is used, time proportional samples are next best. If neither is used, then a grab sample can be collected. The WPDES permit will specify the type and frequency of sample collection. These nutrients must be collected in a special nutrient sample bottle and preserved with sulfuric acid and kept cool (to 6°C or less) until they are analyzed.

C. Fecal Coliforms: An effluent grab sample collected for fecal coliform analysis must be kept cool (to 6°C or less) and sent or brought in to a lab immediately. The maximum holding time for a fecal coliform sample is 6 hours.

D. pH and Dissolved Oxygen: With no preservation method, these samples must be analyzed immediately on-site upon collection because these parameters will change over time.

3.2.4 Discuss purging a monitoring well so that a representative groundwater sample can be collected.

The goal of sampling a monitoring well is to collect unaltered samples that represent the physical and chemical composition of groundwater. Monitoring wells must be purged of four (4) well volumes before a sample can be collected. The goal of purging is to remove the stagnant water that has been sitting in the well casing. Purging brings fresh groundwater through the well screen and into the well casing for a representative groundwater sample. Stagnant water does not represent groundwater. Purge and sample wells in order from least to most contaminated unless the sampler uses dedicated or disposable equipment.

The volume to be purged from a well can be determined from the following equation:

V = pi x (D/2)2 x H x 7.48 gallons per cubic feet x 4

V = total purge volume (four well volumes in gallons)
pi = 3.14
D = inside diameter of well casing (feet)
H = feet of water in well (depth towel bottom minus depth to water)

3.2.5 Describe how groundwater is monitored.

Ground water is typically monitored at the system boundary. Monitoring wells are installed up gradient of lagoons to measure the background groundwater quality and down gradient to measure the impact of the lagoon. Typical monitor parameters include nutrients such as nitrate - nitrogen, ammonia nitrogen, organic – nitrogen, potassium, total dissolved solids, ortho phosphorus, total phosphorus, pH, and trace metals.

3.2.6 Describe a Groundwater Monitoring Report Form

The following is a typical Ground Water Monitoring Report Form. The most important aspects to note are the sample values entered for each parameter for both the background and down gradient wells, as well as the Preventive Action Limits (PAL’s) and Enforcement Standards (ES’s) for those parameters.

Figure 3.2.6.1

Groundwater Monitoring Form

Facility Name :
Contact Address :

Facility Contact :
Phone Number :
Reporting Period : 07/01/2012 - 09/30/2012
Form Due Date : 11/15/2012
Permit Number :

For DNR Use Only

Date Received:
DOC:
FIN:
FID:
Region:
Permit Drafter:
Reviewer:
Office:

Well No/Description: **801/MW1 (801) BACKGROUND WELL**

WI Unique No: Sample Date: 09/12/2012
Casing Top Elevation(Feet, MSL): 863.25
Casing Top Elevation New(Feet, MSL):
Well Is: Broken: N Frozen: N Dry: N Sample Has: Odor: Y Color: Y Turbidity: Y
Abandoned On: Abandoned By:

Parameter	Sample Value	Units	PALs	ESs	LOD	LOQ	Lab Certification Number
166 - Depth To Groundwater	35.9	feet					
227 - Groundwater Elevation	827.35	feet MSL					
329 - Nitrogen, Nitrite + Nitrate (as N) Dissolved	2.9	mg/L	10.7	10.7	0.050	0.15	721026460
106 - Chloride Dissolved	7.8	mg/L	141	250	2.5	5.0	721026460
377 - pH Field	7.56	su	8.3				
325 - Nitrogen, Total Kjeldahl Dissolved	0.27	mg/L			0.12	0.35	721026460
319 - Nitrogen, Ammonia Dissolved	0.15	mg/L	2.1		0.025	0.075	721026460
331 - Nitrogen, Organic Dissolved	00.00	mg/L	2.4		0.12	0.35	721026460
462 - Solids, Total Dissolved	450	mg/L	653				721026460

Well No/Description: **803/MW3 (803) DOWNGRADIENT WELL**

WI Unique No: Sample Date: 09/12/2012
Casing Top Elevation(Feet, MSL): 841.52
Casing Top Elevation New(Feet, MSL):
Well Is: Broken: N Frozen: N Dry: N Sample Has: Odor: Y Color: Y Turbidity: Y
Abandoned On: Abandoned By:

Parameter	Sample Value	Units	PALs	ESs	LOD	LOQ	Lab Certification Number
166 - Depth To Groundwater	14.90	feet					
227 - Groundwater Elevation	826.62	feet MSL					
329 - Nitrogen, Nitrite + Nitrate (as N) Dissolved	9.6	mg/L	10.7	10.7	0.25	0.75	721026460
106 - Chloride Dissolved	250	mg/L	141	250	13	25	721026460
377 - pH Field	7.27	su	8.3				
325 - Nitrogen, Total Kjeldahl Dissolved	0.18	mg/L			0.12	0.35	721026460
319 - Nitrogen, Ammonia Dissolved	0.11	mg/L	2.1		0.025	0.075	721026460
331 - Nitrogen, Organic Dissolved	00.00	mg/L	2.4		0.12	0.35	721026460
462 - Solids, Total Dissolved	810	mg/L	653				721026460

Section 3.3 - Data Understanding and Interpretation

3.3.1 Explain why dissolved oxygen concentrations vary with pond depth.

Oxygen levels vary within ponds depth for a number of reasons. The main reason is the relationship of the organisms within the pond; different bacteria survive under different conditions. Other reasons are the physical actions within the pond, and the loading to the pond. For example:

A. The algae are the main source of oxygen in a pond system. Algae growth is greatest near the surface where light penetration and photosynthesis is the greatest.
B. Oxygen levels decrease with depth, due to less light penetration needed for photosynthesis. The algae use carbon dioxide in the process of photosynthesis and

produce oxygen. The bacteria stabilize organic matter using the oxygen and produce carbon dioxide.
C. The diffusion of oxygen occurs at the surface of ponds and is mixed in the upper layers by wind action. The amount of mixing is limited, so the oxygen levels decrease with depth.
D. The final factor affecting oxygen levels is the organic loading to the system. If organic loadings are small, the oxygen levels will be maintained at greater depths. If organic overloading occurs, the whole pond could go anaerobic.

3.3.2 Discuss how leakage from a pond or lagoon system can be estimated each year.

Leakage is estimated each year in DNR's Compliance Maintenance Annual Reports. Because annual precipitation approximately equals annual evaporation in Wisconsin (see key knowledge 1.2.3), the volume of effluent discharged from a pond system each year should be approximately the amount of influent entering a pond system. In other words, the volume of wastewater coming in and going out should be the same each year. Storage can also be accounted for in this estimation. If the influent cannot be accounted for, whether through effluent discharged and/or storage, then leakage may be occurring. If leakage seems to be occurring each year through CMAR reporting, further leakage studies may need to be undertaken, either by doing on-site leakage testing and/or installing groundwater monitoring wells.

Total influent volume (in million gallons) minus total effluent volume (in million gallons) plus or minus the change in pond/lagoon storage (in million gallons) is the net wastewater loss. The net loss divided by 0.000365 equals the estimated leakage amount in gallons per day. The estimated leakage rate in gallons per acre per day (gpad) is the leakage amount in gpd divided by the total pond surface area (in acres). See Key Knowledge 5.5.1.

3.3.3 Describe how leakage testing can be performed at a wastewater pond site

When leakage is suspected, further evaluation can be done by on-site leakage testing. On-site testing involves isolating the pond suspected of leakage by not allowing any wastewater to enter or leave, if possible. The pond level is measureable using a staffing gage in the pond to measure the water height. Evaporation and precipitation are measured each day, most often using a large barrel partially filled with water. The barrel is placed in the pond to keep the water in the barrel at the same temperature as the pond. The water level in the barrel is measured daily for either precipitation (+) or evaporation (-). Changes in pond and barrel water levels should be relatively the same. On-site leakage testing is usually conducted over a long enough time period (at least 30 days) to allow for climatic variability and data authenticity. Duplicating the leakage test by doing it a second time the same year adds additional confidence in the testing. The reader is referred to the Minnesota Leakage Testing Guidelines for further details and guidance for performing leakage tests on-site

3.3.4 Define groundwater monitoring well

A groundwater monitoring well is a small diameter well, usually constructed of a PVC tube, that is drilled to the groundwater table (surface). It is installed for the specific purpose of either determining the elevation of the groundwater table and/or the physical, chemical, biological or radiological properties of the groundwater.

3.3.5 Describe a groundwater monitoring well system

A groundwater monitoring well system usually consists of an upgradient monitoring well(s) and a number of downgradient monitoring wells, spaced apart and correctly located to accurately measure groundwater elevations and quality. Groundwater moves from higher elevation to lower elevation. The upgradient monitoring well (or control well) measures the background water quality above a treatment pond/lagoon site while downgradient wells measure the impacts, if any, from the site. The groundwater parameters that have to be sampled for and tested are specified in the facility's WPDES permit to determine compliance with meeting groundwater quality standards.

3.3.6 Discuss pond and lagoon system leakage and effects

Wastewater treatment ponds and lagoons are required by code to be designed to have a leakage rate less than 1000 gallons per acre per day (gal/acre/day). Practically speaking, and in order to meet this leakage rate design standard, most ponds and lagoons are lined with a synthetic liner. Synthetic liners most commonly used are polyvinyl chloride (PVC) or high density polyethylene (HDPE) with a nominal 30 ml thickness. Pond and lagoon systems can be lined with clay or bentonite but must have a leakage rate less than the 1000 gal/acre/day design standard.

Leakage from pond and lagoon systems greater than 1000 gal/acre/day has the potential to contaminate groundwater. Untreated or partially treated wastewater can percolate through the soil transporting pollutants to the groundwater below. As contaminated groundwater moves away from the treatment plant site, it can contaminate down gradient wells or if recharging a nearby stream, add pollutants to the stream.

3.3.7 Discuss the effects of pumping sewage to a distant pond or lagoon site.

Raw sewage may become septic if it has to be pumped a long distance (1-5 miles) from a lift station in town to a distant pond/lagoon site outside of town. The septicity is caused by the long detention time of the wastewater in the pipe under anaerobic conditions before it reaches the pond site. Under anaerobic conditions, organic acids and sulfide compounds form. Organic acids can result in increasing the BOD of the wastewater once it reaches the pond site. Hydrogen sulfide results from the bacterial breakdown of organic matter in the absence of oxygen, such as in sewers. The sewage, upon discharge to the influent manhole at the pond site, will release corrosive hydrogen sulfide gas leading to manhole deterioration. Because of this, pond influent manholes should be constructed and properly coated to protect against hydrogen sulfide corrosion.

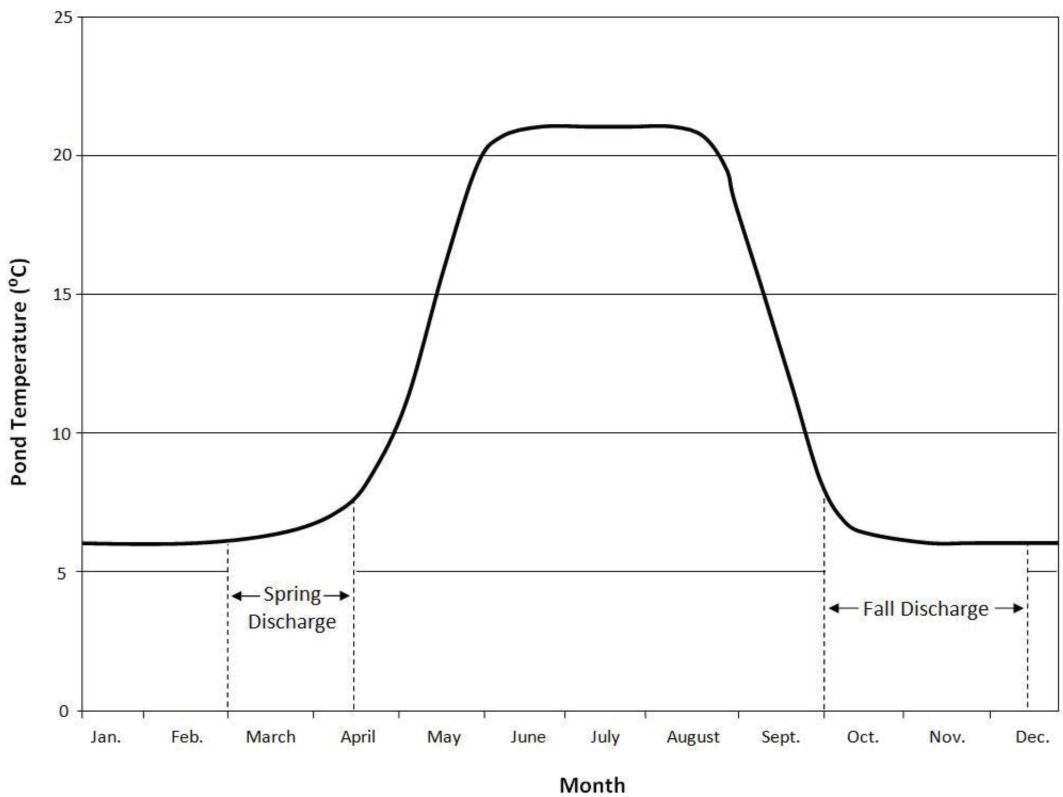
3.3.8 Describe the effect algae can have on effluent suspended solids and phosphorus being discharged from a pond/lagoon.

In a treatment system such as a pond or lagoon, phosphorus is a primary nutrient utilized by algae for growth. Excess phosphorus can result in algal blooms. Algae carried out with the effluent can not only result in effluent suspended solids violations but may also contain phosphorus associated with algal cells. Not discharging excessive algae will ensure meeting effluent limits.

3.3.9 Discuss how monitoring pond temperatures weekly can aid in deciding when to stop/start discharges from a fill & draw system.

Weekly pond temperatures, when graphed (see Figure 3.3.9.1) can help an operator determine the best periods of seasonal discharges. The flat and knee of the curves are usually good times to discharge depending on a plant's effluent limits. Discharging on the steep slopes of a temperature graph (usually turnover periods or bacterial changes) usually results in poorer effluent quality and risks violations. Discharges early in the spring (March-April) before pond temperatures start to rise rapidly is one time to discharge. The best time is usually in the fall/early winter (October-December) after a summer of good treatment. A fill and draw system with ammonia limits usually has to discharge most of their effluent in the fall and early winter after a summer nitrification.

Figure 3.3.9.1



Courtesy of Katherine Robles, WIDNR

Section 3.4 - Performance Limiting Factors

3.4.1 Describe the consequences of not controlling floating mats and rooted weeds in a pond system.

Floating weed mats prevent sunlight from entering the pond, causing anaerobic conditions. Floating duckweed, if not removed, will continue to reproduce and make the problem worse. These mats block sunlight from entering the pond, slowing algae photosynthesis and reducing oxygen production. The pond could go anaerobic. Mats also blow into dead zones of the pond and reduce the effective area of the treatment pond, and hinder surface aeration by reducing wind turbulence. Rooted weeds could pierce the pond seal and lead to leaks. The rooted weeds are food and cover habitat for muskrats. Muskrats build dens into the banks which also lead to significant leakage. Large amounts of rooted weeds in the pond could also cause short circuiting.

3.4.2 Discuss pond short circuiting and its effects.

Pond short circuiting is an uneven flow distribution of wastewater in a pond or lagoon. Wastewater flows through the pond faster in some parts of the pond than in other parts. As a result, wastewater detention time is affected (reduced), with some wastewater getting poorer treatment than in other parts of the pond because the detention time is not long enough. If short-circuiting is severe, inadequate/partial treatment and effluent violations can occur.

Short-circuiting is evaluated through dye-testing. Dyes show how wastewater flows and moves through the pond. To correct short circuiting, baffles, curtains or mechanical mixers can be used in pond to better distribute and improve the uniformity of the flow.

3.4.3 Discuss ammonia removal in Wisconsin ponds or lagoons systems.

Because the conversion of ammonia to nitrates-nitrites (nitrification) is greatly reduced by cold temperatures (< 6 C), it is almost impossible for iced over pond systems that continuously discharge to meet effluent ammonia limits during the winter months (December – March). In cold weather, the reduced nitrification rates has to be considered and a large enough surface area provided for nitrifying bacteria to grow to achieve the proper nitrification rate. Extreme cold weather may still be the performance limiting factor. A tertiary biofilm reactor of some type have been added into or at the end of ponds to favor the growth of nitrifying bacteria such as trickling filters, aerated submerged biofilm reactors, or moving bed biofilm reactors (MBBRS). These add-on technologies for ammonia removal for pond systems have been sparsley applied thus far in Wisconsin.

The storage of treated wastewater during the winter/spring months and converting to a fill & draw mode in may be an option for those pond/lagoon system with winter ammonia limits. If ammonia limits are stringent enough during the entire year, some ponds and lagoons may have difficulty meeting ammonia limits even in the summer and fall depending on the limits.

3.4.4 List the considerations a pond operator would need to make if considering accepting septic tank waste.

A. High BOD and solids
B. High ammonia and phosphorus
C. Septicity (sulfides and lack of DO)
D. Grit

Normally, ponds and aerated lagoons are not designed to accept septage.

Section 3.5 - Corrective Actions

3.5.1 List and discuss causes and corrective actions for problems in stabilization ponds.

Figure 3.5.1.1

Problem	Cause	Corrective Action
Rooted Weeds	Occur in ponds by means of natural processes due to sprouting rhizomes or seed	If possible pull weeds out by hand when they first appear
		If/when there are too many weeds to pull out by hand, cut them down low and then raise the pond level to drown the weeds.
		If possible lower pond level to dry the weeds out (see also 2.4.7 and 3.4.1)
Excessive Duckweed	Natural processes and high nutrient quantities in wastewater	Wait for wind to blow the duckweed to one side of the pond and then rake it out or suck it out with a vacuum truck. (see also 1.3.5 and 3.4.1)
Floating Mats	Floating sludge, blue green algae, oil/grease	Break up mats with a portable pump, rakes, or a motor boat. Broken mats will typically sink.
		Rake them out and remove them.
		If mat is composed of oil/grease then a grease control program should be implemented (see also 2.4.6)
Low Dissolved Oxygen	Poor light penetration, low detention time, high BOD loading	Remove duckweed if it covers 40% of the pond or greater
		If possible reduce loading by switching to parallel operation
		If possible detain wastewater for longer time period to obtain better treatment
		Add supplemental aeration by means of pumps or motorboat operation
		Additional chemical treatment

3.5.2 List and discuss causes and corrective actions for problems in aerated lagoons.

Figure 3.5.2.1

Problem	Cause	Corrective Action
Excessive Rooted Weeds	Seeds get carried to ponds by wind or birds	If possible pull weeds out by hand when they first appear.
		If/when there are too many weeds to pull out by hand, cut them down low and then raise the pond level to drown the weeds.
		If possible lower pond level to dry the weeds out (see also 2.4.7 and 3.4.1).
Excessive Duckweed	Ducks and geese can carry duckweed into the pond in their webbed feet	Wait for wind to blow the duckweed to one side of the pond and then rake it out or suck it out with a vacuum truck (see also 1.3.5 and 3.4.1).
Insufficient Dissolved Oxygen	Inadequate aeration	Provide more air by turning up the aerators or adding more aerators.
	Excessive organic loading	Find source and try to reduce organic loading.
		Switch to parallel operation to reduce loading in the primary cell (see also 1.3.3).

3.5.3 List and discuss possible causes and corrective actions for excessive algae in the effluent.

Excessive algae growth is usually caused by one or more of these conditions:
1. Warm pond water and more sunshine
2. Excessive nutrients, especially phosphorus
3. Organic overloading of the pond

Corrective actions could be one or more of the following:
1. Draw off effluent from below the surface where algae are less concentrated
2. Reduce organic loading, or add mechanical aeration
3. Use a metal salt to precipitate phosphates
4. Use an effluent sand filter to remove algae
5. Add barley straw to the pond in the spring, this often inhibits algae growth
6. Add a dye to the final cell to block sunshine, or cover the cell to block sunshine
7. If possible use another cell for discharge, and let the other rest until the algae die off

3.5.4 List and discuss possible causes and corrective actions for pond organic overloading.

When properly operated and loaded, pond systems will normally experience odor problems only in the spring, right after ice-out. This odor is caused because of anaerobic conditions that occurred under the ice. In most cases, this condition may only last from a few days to a week, until normal aerobic conditions are restored. When a pond system is not operated properly; when receiving an industrial slug load, or when being overloaded organically, anaerobic conditions can persist for some time with significant odors from both anaerobic conditions and the die-off of blue-green algae dominating the system. The pond system may have blue-gray appearance with the odor.

The first action to correct organic overloading (> 20 lbs BOD/acre/day) is to locate and control/reduce the sources of the high organic loading, especially if it is coming from a business or industry. A few operational changes that can be made are running the ponds in parallel instead of series (see key knowledge 1.3.3) , adding supplemental aeration to one or more of the ponds or recirculating final effluent back to the first or second ponds. Recirculation of effluent involves setting up a large pump and piping from the end of the last pond back to ponds at the front end of the system. This concept is similar to the operation of recirculating media filters and trickling filters. If organic overloading is chronically above 20 lbs BOD /acre/day, an engineering consultant should be contact to evaluate the upgrading needs of the treatment system.

3.5.5 Discuss control and removal methods for burrowing animals.

Burrowing animals can cause damage to pond banks and liners, which can lead to significant leakage. Vegetation control helps to discourage burrowing animals from establishing a habitat. Muskrats damaging wastewater treatment pond or lagoon dikes can be controlled through trapping or shooting (Wisconsin Administrative Code NR 12.10(1)(b)1.d.). Turtles can also be removed through trapping. Trapping can be done year round within the confines of the facility's property.

3.5.6 List and discuss possible causes and corrective actions for seepage cells that do not seep.

Figure 3.5.6.1

Problem	Cause	Corrective Action
Seepage cell that does not seep	Compacted cell bottom	Rework cell bottom with mechanical equipment to loosen and aerate soil
	Hydraulic overload	Reduce overload by alternating seepage cell loading
	Sludge build-up	Remove sludge from cell. Correct operation of treatment ponds preceding seepage cells.
	Dead matted vegetation	Remove vegetation. Rework cell bottom with mechanical equipment to loosen and aerate soil.

3.5.7 Discuss causes and corrective actions for problems with overland flow treatment.

If an overland flow system is ponding due to hydraulic overloading, the application rate should be reduced to design rate or less. Over time solids will build up at the top of the slope of an overland flow system. These solids will need to be incorporated into the soil to prevent smothering of plantings and poor treatment. If channeling starts to occur over time a consultant should be contacted for possible regarding and replanting.

Chapter 4 - Safety and Regulations

Section 4.1 - Regulations and Procedures

4.1.1 Discuss land treatment systems and groundwater standards.

Wisconsin Administrative Code NR 140 - Groundwater Quality defines the performance standards for land infiltration systems such as seepage cells. The specific groundwater standard of most concern for municipal systems is the 10 mg/L nitrate-nitrogen standard. Although nitrogen removal can also occur in the soil, the removal efficiency which can be achieved in any particular case can vary considerably. As a result, Wisconsin Administrative

Code NR 206 – Land Disposal of Municipal and Domestic Wastewaters contains an effluent discharge limit of 10 mg/L for total nitrogen (total nitrogen includes nitrate, nitrite, ammonia and organic nitrogen) to ensure the 10 mg/L nitrate standard is met in the groundwater. The other effluent limits specified in NR 206 are 50 mg/L for BOD and 250 mg/L for chlorides.

4.1.2 Discuss reasonable pond security precautions against trespassing and vandalism.

Security is necessary to protect the area from unauthorized access and to protect those who enter the facility. The community could become subject to liability and legal action if it fails to make a reasonable effort to restrict trespassing.

Reasonable fencing includes:
A. Gates and locks which are kept secure at all times. Gates to restrict vehicles and ATV's. At a minimum, steel or aluminum gates with solid anchor posts and a sign are required.
B. Fences include a sturdy wire fence with signs. Fence lines should be brushed and signed at suitable intervals.
C. Regular drive-by patrol by the local police is recommended. Work with adjacent property owners to report suspicious vehicles or people in the area.

4.1.3 Discuss suspended solids effluent variances for excessive algae.

A suspended solids variance may be made for aerated lagoons and stabilization ponds. The suspended solids limit may be raised to a maximum of 60 mg/L for a 30-day average. This variance is not applicable to polishing or holding ponds which are preceded by other biological or physical/chemical treatment processes.

4.1.4 Discuss corrective actions for Enforcement Standard exceedances.

The owner/operator must notify the department in writing when the concentration of a substance in the groundwater exceeds the Enforcement Standard. The department must be notified in accordance with any applicable deadlines, or within ten days after when the exceedance results were received. The notice includes the cause and significance of the concentration. The department will respond, and possibly require further reporting with the facility assessing the cause and significance of the increased substance, including a plan on how to achieve compliance with the Enforcement Standard in the future. Depending on the severity and frequency of the exceedance, a wastewater engineering consultant may need to be involved.

4.1.5 List the operating requirements for industrial and municipal ridge and furrow systems.

Industrial:
1. Ridge top grasses should be cut and removed, or burned each spring and if possible, removed at least once later in the growing season.
2. Alternate discharge to sections of the system to allow resting periods to maintain the treatment capability of the soil.
3. Sections must have sufficient resting to allow soil conditions to become unsaturated and aerobic prior to being loaded.
4. At least 5 feet of separation must exist between the bottom of the furrows and ground water.

Municipal:
1. Discharge is limited so the discharge and precipitation does not flood the ridges and overflow the system.
2. Alternate discharge to sections of the system to allow sufficient resting periods.
3. The average hydraulic application rate may not exceed 10,000 gallons per acre per day. This is based on hydrogeologic conditions, soil texture, permeability, topography, cover crop and wastewater characteristics. The recommended range is 2,000 to 5,000 gallons per acre per day based on a monthly average.
4. The annual total nitrogen applied is limited to the annual nitrogen need of the cover crop.
5. Soil testing is done annually for available nitrogen, phosphorus and potassium, and pH to determine if the nutrients applied are meeting the agronomic needs of the cover crop.

4.1.6 List the operating requirements for industrial and municipal spray irrigation systems.

Industrial:
1. The load/rest cycle must provide time for the soil organisms to decompose the organic pollutants in wastewater, for organic solids on the ground surface to decompose, and for the soil column to reaerate.
2. Cover crops are to be cut and removed at least twice a year to stimulate vegetation growth and nutrient removal.
3. Soil testing should be done annually for available nitrogen, phosphorus and potassium, and pH to determine if the nutrients applied are meeting the agronomic needs of the cover crop.

Municipal:
1. Discharge is limited to prevent any runoff of effluent from the site and to prevent ponding.
2. Water may not be sprayed during any rainfall event that would cause runoff.
3. Only uncontaminated storm water may be allowed to drain from the site.
4. The average hydraulic application rate may not exceed 10,000 gallons per acre per day. The recommended range is 2,000 to 7,000 gallons per acre per day based on a monthly average.
5. The annual total nitrogen applied is limited to the annual nitrogen need of the cover crop.
6. Soil testing is done annually.

4.1.7 List the operating requirements for industrial and municipal overland flow systems.

Industrial:
1. Alternate discharge to sections of the system to allow sufficient resting to dry accumulated solids and maintain a complete grass cover.
2. Cover crops are to be cut and removed at least twice a year.

Municipal:
1. Alternate discharge to sections of the system to allow sufficient resting to dry accumulated solids and maintain a complete grass cover.
2. The hydraulic application rate is a flow rate per unit width of slope. The rate should be low when the vegetative cover is not developed sufficiently. A lower hydraulic application rate helps grow the vegetation and filter mat necessary for effective wastewater treatment. Once

vegetation is established, the hydraulic application rate can be increased per system recommendations.

Section 4.2 - Safety

4.2.1 Discuss safety concerns for limiting public access to ponds and lagoons.

A pond or lagoon may be attractive to hunters, fishers, or playing children. Ponds have steep slopes and pose the risk of drowning. Any recreational activities risk exposure to waterborne pathogens associated with sewage. It is important that adequate fencing and signage be provided. Fencing also discourages trespassing and vandalism.

4.2.2 Discuss safety precautions that should be practiced when controlling vegetation.

Spraying:
Applicator must wear Personal Protective Equipment (PPE) to prevent exposure to pesticides. Follow the product label for safety recommendations and wash hands after working with these products. Apply using an applicator to direct the spray. At the recommended dosage, spray vegetation carefully to control its potential of getting into the water.

Manual removal:
Wear protective clothing and be sure co-workers are aware of your location. Work with another person if necessary. Wear a safety life vest if working from a boat or on the shoreline.

4.2.3 Discuss safety precautions that should be practiced while using grass cutting equipment around a pond.

Use caution when cutting next to electrical cables. Use care when spraying weeds around electrical cables and equipment. The spray could conduct a current and cause electrical shock. Use caution when operating mowing equipment on banks. Steep banks can be very hazardous. Tractors with side mount mowers are strongly encouraged.

4.2.4 List the personal safety precautions that should be practiced by persons operating a pond system.

1. Never perform any hazardous task around a pond without being accompanied by someone.
2. Wear life jackets when working around or on ponds.
3. Use care when mowing grass on steep slopes.
4. Follow confined space entry procedures at all times.
5. Use lockout/tagout procedures on electrical equipment.
6. Turn aerators off and wear a life jacket when performing maintenance tasks from a boat (a person who falls overboard could sink faster if the aerators are working).
7. Follow all safety precautions when using chemicals.
8. Wash-up after contact with sewage.
9. Use care if walking on a frozen pond.

4.2.5 Discuss the importance of maintaining chemical delivery, storage, and usage records.

All phosphorus removal chemicals are considered hazardous materials. Therefore all amounts delivered, stored, and used need to be accounted for. Material Safety Data Sheets (MSDS) are required to be kept on-site and available. Contact the DNR in event of a spill.

4.2.6 Discuss the reporting requirements for phosphorus removal chemicals under Federal, State, and Local laws.

In order to comply with Sections 311 & 312 - Community Right-to-Know Requirements of Title III of the Superfund Amendments and Reauthorization Act (SARA Title III), Wisconsin Statute 166.20 and Chapter SERB 1 of the Wisc. Admin. Code, the Wisconsin State Emergency Response Board requires that all facilities having a hazardous chemical with Material Safety Data Sheets (MSDS) present at their facility in large volumes (greater or equal to 500 lbs) to annually submit a Tier two, Emergency and Hazardous Chemical Inventory Form. If there are questions about the need to report hazardous chemical storage, contact your county hazardous waste coordinator.

The laws require that the chemical inventory report be sent annually to:
- State Emergency Response Commission.
- Local Emergency Planning Committee.
- Local Fire Department.

The report shall include the following information:
1) Chemical and common name of the chemical.
2) Estimate of maximum amount of chemical at the facility in the proceeding year.
3) Estimate of the average daily amount of chemical at the facility in the proceeding year.
4) Description of the manner of storage.
5) Location of the stored chemical at the facility.

4.2.7 Discuss preventative spill measures and procedures when handling phosphorus removal chemicals.

Storage tanks must have secondary containment that equals the volume of the storage tank. During unloading of delivery vehicles, place containment pails under potential leak points and when uncoupling fill lines. Inspect and maintain fill lines and valves. Inspect storage tank and hardware for integrity. Provide on-site containment equipment such as absorbent boom, sandbags, etc., and seal your yard/storm drains to prevent off-site loss of chemical. Pay attention to what you are doing.

4.2.8 Discuss what should be done in the event of a phosphorus removal chemical spill.

1. Any spill of hazardous material should be reported to DNR within 24 hours and to the local emergency response agencies.
2. Contact CHEMTREX for further spill response and cleanup advice.

Chapter 5 - Calculations

Section 5.1 - Flow and Loading

5.1.1 Given data, calculate the pounds of BOD5 entering the stabilization pond each day.

GIVEN:
Influent flow = .04 MGD
Influent BOD = 210 mg/L
One gallon of water weighs 8.34 pounds

FORMULA & SOLUTION:
Influent BOD5 (lbs/day) = influent flow (MGD) × influent BOD5 (mg/L) × 8.34 lbs/gal
= 0.04 MGD × 210 mg/L × 8.34 lbs/gal
= 70 lbs/day

5.1.2 Given data, calculate the BOD5 loading to a four acre pond in pounds per acre per day.

GIVEN:
Influent flow = .04 MGD
Influent BOD = 210 mg/L
Pond surface area = 4 acres
One gallon of water weighs 8.34 pounds

FORMULA & SOLUTION:
Influent BOD5 (lbs/acre/day) = [influent flow (MGD) × influent BOD5 (mg/L) × 8.34 lbs/gal] ÷ pond surface area
= [0.04 MGD × 210 mg/L × 8.34 lbs/gal] ÷ 4 acres
= 17.5 lbs/acre/day

Section 5.2 - Volume and Surface Area

5.2.1 Given data, calculate pond surface area in acres.

GIVEN:
Pond length = 400 feet
Pond width = 300 feet
1 acre = 43,560 square feet

FORMULA & SOLUTION:
Area of pond (sq. ft.) = length (ft) x width (ft)
= 400 ft x 300 ft
= 120,000 sq. ft.

Area of pond (acres) = surface area (sq. ft.) ÷ 43,560 (sq. ft./acre)
= 120,000 sq. ft. ÷ 43,560 sq. ft./acre
= 2.75 acres

5.2.2 Given data, calculate pond volume in gallons.

GIVEN:
Pond width at mid-depth = 200 feet
Pond length at mid-depth = 500 feet
Pond depth = 6 feet
1 cubic foot = 7.48 gallons

FORMULA & SOLUTION:
Volume (gallons) = length at mid-depth (ft) x width at mid-depth (ft) x depth (ft) x 7.48 (gal/cu. ft.)
= 500 ft x 200 ft x 6 ft x 7.48 gal/cu. ft.
= 4,488,000 gallons
= 4.5 million gallons (MG)

5.2.3 Given data, calculate the volume of water in a groundwater monitoring well casing.

GIVEN:
Inner well casing radius = 1 inches
Depth of water = 15 feet
1 cubic foot = 7.48 gallons
1 cubic foot = 1728 cu. in.
1 foot = 12 inches

FORMULA & SOLUTION:
Volume (gallons) = [radius (in)]² x 3.14 x depth (ft) x 12 (in/ft) x 7.48 (gal/cu. ft.) ÷ 1728 (cu. in./cu. ft)
= [1 in]² x 3.14 x 15 ft x 12 in/ft x 7.48 gal/cu. ft.÷ 1728 cu. in./cu. ft
= 2.45 gallons

Section 5.3 - Detention Time

5.3.1 Given data, calculate a stabilization pond's detention time in days.

GIVEN:
Surface area = 8 acres
Average depth = 4 feet
Average daily flow = 60,000 gallons/day
1 acre = 43,560 square feet
1 cubic foot of water = 7.48 gallons

FORMULA & SOLUTION:
Volume (gal) = surface area (acres) x 43,560 (sq. ft./acre) x depth (ft) x 7.48 (gal/cu. ft.)
= 8 acres x 43,560 sq. ft./acre x 4 ft x 7.48 gal/cu. ft.
= 10,426,522 gallons

Detention time (days) = volume (gal) ÷ avg. daily flow (gal/day)
= 10,426,522 gallons ÷ 60,000 gal/day
= 173.78 days

5.3.2 Given data, calculate the detention time of a 3 pond system.

GIVEN:
Number of ponds operating in series = 3 ponds
Volume of each pond = 5,000,000 gal/pond
Daily Flow = 92,000 gal/day

FORMULA & SOLUTION:
Detention time (days) = [pond volume (gal/pond) x number of ponds] ÷ daily flow (gal/day)
= [5,000,000 gallons/pond x 3 ponds] ÷ 92,000 gal/day
= 15,000,000 gallons ÷ 92,000 gal/day
= 163 days

Section 5.4 - Discharge

5.4.1 Given data, calculate the volume of water discharged in gallons.

GIVEN:
Drawdown depth = 3.0 feet
Pond length = 675 feet
Pond width = 420 feet
1 cubic foot of water = 7.48 gallons

FORMULA & SOLUTION:
Volume (gal) = length (ft) x width (ft) x drawdown depth (ft) x 7.48 (gal/cu. ft.)
= 675 ft x 420 ft x 3.0 ft x 7.48 gal/cu. ft.
= 6,361,740 gallons
= 6.4 million gallons (MG)

5.4.2 Given data, determine the fall drawdown volume and depth.

The daily average influent flow into a fill and draw pond system is 30,000 gallons per day. An operator needs to drawdown the pond in November to allow for enough storage during the 121 days of winter (December through March). The pond is at 5 feet. Allowing for some extra flow during spring thaw for I/I, the operator determines he wants 150 days of storage. Using the graph provided, to what depth must the operator lower the pond?

GIVEN:
Daily influent flow = 30,000 gallons/day
Pond storage volume needed = 150 days
See figure 5.4.2.1 for graph.

FORMULA & SOLUTION:
Total drawdown volume (gal) = daily influent flow (gal/day) x days of storage needed (days)
= 30,000 gpd x 150 days
= 4,500,000 gallons

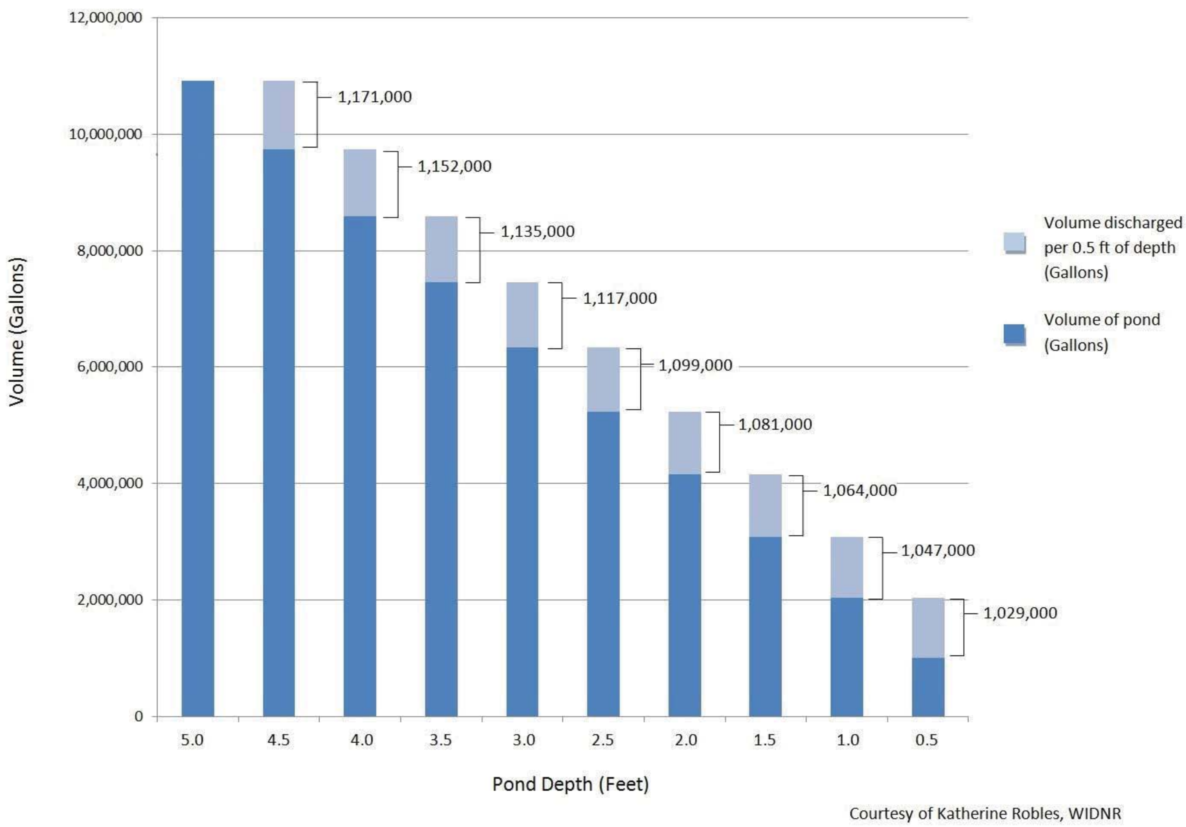
Reading the graph, the following volumes per half a foot of depth is shown:
5.0-4.5 feet = 1,171,000 gallons
4.5-4.0 feet = 1,152,000 gallons
4.0-3.5 feet = 1,135,000 gallons
3.5 -3.0 feet = 1,117,000 gallons

Cumulative volume per ½ foot of drawdown = 1,171,000 + 1,152,000 + 1,135,000 + 1,117,000

= 4,575,000 gallons

The operator must discharge enough wastewater in November to lower the pond from 5 feet to 3 feet.

Figure 5.4.2.1



5.4.3 Given data for a fill and draw pond system, calculate the volume of draw-down required and the time required to achieve draw-down.

GIVEN:
Pond width = 200 feet
Pond Length= 300 feet
Draw down depth = 2 feet
Hydraulic discharge limit = 40,000 gal/day
1 cubic foot = 7.48 gallons

FORMULA & SOLUTION:
Draw-down volume (gal) = length (ft) x width (ft) x draw-down depth (ft) x 7.48 (gal/cu. ft.)
= 300 ft x 200 ft x 2 ft x 7.48 gal/cu. ft.
= 897,600 gallons

Draw-down time (days) = Draw-down volume (gal) ÷ Hydraulic discharge limit (gal/day)
= 897,600 gallons ÷ 40,000 gal/day
= 22.4 days

Section 5.5 - Leakage

5.5.1 Given data, estimate the leakage from a wastewater stabilization pond.

GIVEN:
Total Annual Influent (MG) = 9.125 million gallons per year
Total Annual Effluent (MG) = 7.850 million gallons per year
Pond Surface Area = 2.5 acres
1 year/MG = 0.000365 days/gallon

FORMULA & SOLUTION:
Leakage rate (gpad) = [total annual influent volume (MG/year) – total annual effluent (MG/year) ÷ 0.000365 (MG·day/gal·year)] ÷ pond surface area (acres)
= [9.125 MG/year – 7.850 MG/year ÷ .000365 MG·day/gal·year] ÷ 2.5 acres
= 3493 gal/day ÷ 2.5 acres
= 1397 gal/acre/day

References and Resources

1. **OPERATION OF MUNICIPAL WASTEWATER TREATMENT PLANTS (2008)**

   MANUAL OF PRACTICE NO. 11 (6TH EDITION), VOLUME 2 – LIQUID PROCESSES. WATER ENVIRONMENT FEDERATION. MCGRAW HILL PUBLISHERS.

   www.wef.org

2. **OPERATION OF WASTEWATER TREATMENT PLANTS – A FIELD STUDY TRAINING**

   5TH EDITION. CALIFORNIA STATE UNIVERSITY –SACRAMENTO, OFFICE OF WATER PROGRAMS

   http://www.owp.csus.edu/ or available through inter-library loan at http://aqua.wisc.edu/waterlibrary

3. **PRINCIPLES OF DESIGN AND OPERATIONS OF WASTEWATER TREATMENT POND SYSTEMS FOR PLANT OPERATORS, ENGINEERS, AND MANAGERS**

   LAND REMEDIATION AND POLLUTION CONTROL DIVISION, NATIONAL RISK MANAGEMENT RESEARCH LABORATORY, OFFICE OF RESEARCH AND DEVELOPMENT, U.S. ENVIRONMENTAL PROTECTION AGENCY, CINCINNATI, OHIO

   http://www.epa.gov/nscep/index.html

4. **STABILIZATION POND OPERATION AND MAINTENANCE MANUAL**

   MINNESOTA POLLUTION CONTROL AGENCY – TRAINING, CERTIFICATION AND OUTREACH UNIT, POLICY AND PLANNING DIVISION, 520 LAFAYETTE ROAD NORTH, ST. PAUL, MINNESOTA, 55155

5. **INTRODUCTION TO LAGOONS**

   LAGOON SYSTEMS IN MAINE, DEPARTMENT OF ENVIRONMENTAL PROTECTION – STATE OF MAINE, 17 STATE HOUSE STATION, AUGUSTA, MAINE 04333-0017

   http://www.lagoonsonline.com/introduction2.htm

6. **OPERATIONS MANUAL: STABILIZATION PONDS (1977)**

   U.S. ENVIRONMENTAL PROECTION AGENCY. WASHINGTON, D.C. 20460

7. **GROUNDWATER SAMPLING DESK REFERENCE**

   WISCONSIN DEPARTMENT OF NATURAL RESOURCES. BUREAU OF DRINKING WATER AND GROUNDWATER. SEPTEMBER 1996. PUBL-DG-037 96.

   http://dnr.wi.gov/topic/Groundwater/documents/pubs/desk_a.pdf
   http://dnr.wi.gov/topic/Groundwater/documents/pubs/desk_b.pdf

8. **GROUNDWATER SAMPLING FIELD MANUAL.**

   WISCONSIN DEPARTMENT OF NATURAL RESOURCES. BUREAU OF DRINKING AND GROUNDWATER. SEPTEMBER 1996. PUBL-DG-038 96.

   http://dnr.wi.gov/topic/Groundwater/documents/pubs/field.PDF

9. PREFILL AND WATER BALANCE CRITERIA

MINNESOTA POLLUTION CONTROL AGENCY. DIVISION OF WATER QUALITY. MUNICIPAL WASTEWATER TREATMENT. DECEMBER 2010. 520 LAFAYETTE ROAD NORTH, SAINT PAUL, MINNESOTA 55155.

http://www.pca.state.mn.us/index.php/view-document.html?gid=15336