NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WASTE TREATMENT LAGOON (Anaerobic)

(No.)

CODE 359

DEFINITION

An impoundment made by excavation or earth fill for biological treatment of animal or other agricultural waste.

PURPOSE

To biologically treat organic waste efficiently and effectively so as:

1. to reduce odor;
2. to reduce surface and ground water contaminants;
3. to liquefy organic waste and reduce the nutrient content of the effluent.

CONDITIONS WHERE PRACTICE APPLIES

1. The lagoon is a component of a conservation plan and Comprehensive Nutrient Management Plan (CMMP), and shall be compatible with other components of the conservation plan and CNMP. The CNMP shall be written to utilize or export the annual nutrient production from the production facility in the initial plan; or when excess nutrients are anticipated, provide the producer with an estimate of the acreage necessary to utilize accumulated sludge.

2. The total height of the dam is 25 ft or less and the storage volume is 50 acre-ft or less. Total height is the vertical measurement from the low point on the downstream toe to the top of the dam.

3. Where failure of the structure will not result in the loss of life, in damage to homes, commercial or industrial buildings, main highways or railroads, or interrupt the use of public utilities.

4. Where adequate water supply is available to precharge the lagoon and supply fresh water for maintenance.

CRITERIA

The criteria stated below are the minimum criteria for facilities installed to meet the purpose of this standard. Additional criteria may also apply for installations requiring a State of Ohio Permit to Install (PTI) or National Pollution Discharge Elimination System (NPDES) permit.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.oh.nrcs.usda.gov).

Location

To minimize the potential for contamination of streams, facilities should be located outside of flood plains; however, if site restrictions require location within the flood plain, protect the facility from inundation and damage from a 25-year flood event, or larger if required by laws, rules, or regulations. Locate facilities so that prevailing winds and landscape elements such as buildings landforms, and vegetation, minimize odors and protect or improve the visual quality of the site.

Locate facilities:

- Minimum of 300 ft. from neighboring residences
- Not within the emergency management zone of public surface water supply as designated under the Source Water Assessment and Protection Program, or not within 1500 ft. of the surface supply intake when a emergency management zone has not been established.
- The minimum separation distances from wells and sinkholes are shown in Table 1

Table 1 - Minimum setback distances from water supply wells, sinkholes & agricultural drainage wells

Water well designation	Earthen lagoons
Public water system supply well (Community, and Non-transient Non- community (NTNC)).	Not within the inner management zone (1 year time of travel), or not with 1000 ft. when the time of travel has not been established.
Public water system supply well (Community, and Non-transient Non- community (NTNC)).	Not within a protection area determined as highly susceptible (5 year time of travel).
Transient non-community (TNC) public water system supply well.	300 ft
Private water supply well not controlled by the owner of the facility to be installed under this practice.	300 ft
Private water supply well controlled by the owner of the facility to be installed under this practice.	300 ft. unless it is determined by an engineering geologist or registered professional engineer that a lesser distance will not pollute the well; in this case the distance can be reduced to 100 ft.
Known Sinkhole or Agricultural Drainage Well	300 ft. unless it is determined by an engineering geologist or registered professional engineer that a lesser distance with special design considerations will not cause pollution; in this case the distance can be reduced to 100 ft.

- The Federal Emergency Management Agency (FEMA) has designated Established Regulatory Floodways in the floodplains of some Ohio rivers and streams. Do not locate facilities within an Established Regulatory Floodway.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.oh.nrcs.usda.gov).

Biological Hazard. The impact of a sudden breach, liner failure or accidental release needs to be evaluated because of potential water contamination and biological hazard to humans. Section 651.0204 of the Agricultural Waste Management Field Handbook is to be used as a guide for this evaluation. Decisions regarding the evaluation are to be documented in the design file.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume.

Features, safeguards, and/or management measures to minimize the risk of failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 2 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 2 may be significantly affected:

1. Manure management plan and crop rotation that facilitates frequent drawdown intervals
2. An auxiliary (emergency) spillway
3. Additional freeboard
4. Storage for wet year rather than normal year precipitation
5. Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes

Table 2 - Potential Impact Categories from Breach of Embankment or Accidental Release

1. Surface water bodies -- perennial streams, lakes, wetlands, and estuaries
2. Critical habitat for threatened and endangered species.
3. Riparian areas
4. Farmstead, or other areas of habitation
5. Off-farm property
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

6. Secondary containment

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 2 may be significantly affected:

1. Outlet gate locks or locked gate housing
2. Secondary containment
3. Alarm system
4. Another means of emptying the required volume

Considerations for Minimizing the Potential of Lagoon Liner Failure.

Sites with categories listed in Table 3 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration will be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed in Table 3 may be significantly affected.

Table 3 - Potential Impact Categories for Liner Failure,

and High pollution Potential Areas

1. Any underlying aquifer zone is less than 15' below the bottom of the planned facility.
2. The vadose zone is rock.
3. The aquifer is a domestic water supply or ecologically vital water supply.
4. The site is located in an area of solutionized bedrock (karst) such as limestone or gypsum.
5. The site has a DRASTIC rating of 160 or greater.

Should any of the potential impact categories listed in Table 3 be affected, design considerations in Table 4 are to be used. Clay & synthetic liners are to meet the following criteria shown here and in the *Lining Lagoons or Settling Facilities* section of this standard:

1. A clay liner designed in accordance with procedures of AWMFH Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1×10^{-6} cm/sec.
2. A flexible membrane liner over a clay liner.
3. A geosynthetic clay liner (GCL) flexible membrane liner.
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness.

Soil and Foundation. Where available, use the Ohio Department of Natural Resources (ODNR), Division of Water, Ground Water Pollution Protection (DRASTIC) Maps to determine the pollution potential for each site. Areas having a pollution potential index above 160 indicate a high potential to pollute groundwater. All sites in a high pollution potential area or within an EPA designated Sole Source Aquifer boundary, or those that require a permit to install from the State of Ohio, require a geological exploration completed by an engineering geologist or registered professional engineer competent to perform such work. Consider the need for laboratory testing prior to design.

Examine the ODNR County Ground Water Resource maps where available, and near-by well logs to determine potential aquifer yields and depth to the aquifer. Information obtained from the DRASTIC maps, County Ground Water Resource maps, and well logs shall be included in the facility design report.

A subsurface geological exploration is required for all facilities to determine conditions that may adversely affect groundwater quality. The total number of test pits or borings required is dependent on the soils and geological formations on site. A rule of thumb is a minimum of four test pits or borings placed at each corner of an approximately 200 foot x 200 foot, or smaller, area. Additional test pits will be required for larger lagoons. In all cases, the

complexity of the subsurface conditions and susceptibility to leakage will determine the number of test pits. Extend exploration borings and/or test pits to a minimum of 5 ft below the planned bottom of the facility. A trackhoe is recommended for all subsurface explorations. The use of a soil-exploration type of drill rig may also be necessary in sites that lie above a 100 gpm or greater aquifer. Record (log) all soil and rock types present, their depths, their moisture conditions, depths to ground water flow, and an estimate of the flow. Guidance on logging foundation conditions is given in AWMFH, Chapter 7, Amendment OH 7, Geology and Groundwater Considerations. Determine the minimum requirements for design as per the findings of the geological exploration. Include the geological exploration logs in the design documentation. Table 4 shall be used to determine the construction needed to protect groundwater:

Table 4 – Minimum Design Criteria for the protection of Groundwater

Criteria	Earthen Lagoon
ODA permitted facility	Recommendations of geotechnical report inclusive of lab tests, and ODA rules
DRASTIC Index < 160 and > 15' to aquifer zone	Recommendation of geology report; lab analysis not necessary unless directed by on-site soil logger
DRASTIC Index > 160 and > 15' to aquifer zone or DRASTIC Index < 160 and < 15' to aquifer zone	Lab analysis necessary; Design to min criteria in AWMFH Appendix 10-D
DRASTIC Index > 160 and < 15' to aquifer zone	3' of compacted soil below lagoon bottom designed to min criteria in AWMFH Appendix 10-D, plus synthetic liner with leak detection
Bottom of facility is within 15' of rock that is not an aquifer (In addition to DRASTIC & aquifer zone criteria)	3' of compacted soil below lagoon bottom Design to min criteria in AWMFH Appendix 10-D
Bottom of facility is within 15' of rock that is an aquifer (In addition to DRASTIC & aquifer zone criteria)	3' of compacted soil below lagoon bottom designed to min criteria in AWMFH Appendix 10-D, plus synthetic liner with leak detection

Maintain a minimum thickness of 15 feet of soil (*in-situ* soil plus liner, if necessary) between the bottom of the lagoon and the top of the aquifer zone of all aquifers unless special design considerations as shown in table 4 are used. (The depth to aquifers can be obtained from well logs). Liners are to be designed following the recommendation of a geotechnical report following lab testing of the soil to be used in the liner.

All earthen liners above aquifers shall meet the hydraulic conductivity requirements for permitted facilities and be designed for specific discharge of no more than 1×10^{-6} cm/sec.

Ground water flow shall be prevented from entering the bottom of the facility after construction by maintaining a minimum of 3 feet of impermeable in- place soil (inclusive of a well compacted liner, if necessary) between the water and the bottom of the facility. Maintain a minimum of 3 ft (inclusive of a liner, if necessary) between the bottom of the facility and bedrock that is not an aquifer. See Appendix A of this standard for aquifer definition.

All ground water seepage shall be sealed off with a liner when appropriate, or drained away from the facility by the use of a perimeter drain. Drains shall be located as far away from the inside slope as possible. However, field conditions may require a drain to be placed on the inside slope of a lagoon. In such cases, the drain shall be covered by a minimum of three feet of well compacted soil liner and be installed with a down slope inspection port for future monitoring. The inspection port shall consist of a capped watertight riser with a minimum diameter of 8 in. The top of the riser shall be elevated a minimum of 12" above the ground and located a minimum of 50 ft. from the edge of the lagoon where it will not be subjected to damage, or otherwise protected.

In all cases, ground water pollution is to be prevented. Therefore, additional measures may be necessary. They may include: 1) placing a compacted soil liner containing hydraulic conductivity reducing additives, 2) an impermeable membrane or barrier placed according to the manufacturer's recommendations, or 3) current technology may offer other acceptable solutions.

No existing subsurface drainage line shall be allowed to remain within fifty feet of the edge of the waterline of any manure treatment lagoon. Existing subsurface drainage lines within this area shall be removed or relocated. Subsurface drainage lines installed as part of the project are allowed within the 50' area as follows:

- Perimeter drain installed for seepage control under a liner.
- Subsurface drains installed as part of a surface water diversion system adjacent to the facility. These lines must be no closer than 25 ft. from the design waterline.

Soil Compaction. The following are minimum requirements for compacting CL or SC soils used for embankments and for sealing the lagoon bottom as necessary when special liners are not required.

- *Precompacted Lift thickness:* The lift thickness shall be equivalent to the length of the feet of the sheepsfoot roller plus 3 inches; not to exceed 9 inches in total thickness.
- *Maximum rock diameter:* 3 inches.
- *Minimum Moisture content:* - The soil material shall be of sufficient moisture to easily form it into a moist, somewhat soft, ball by hand and not develop any cracks. This moisture content approximates optimum plus 2%.
- *Compaction equipment:* a minimum 200-psi sheepsfoot roller.
- *Compaction effort:* a minimum of 6 passes of the roller over all points of each lift. When the moisture content is adequate, the sheepsfoot roller will penetrate the soil and ride on the drum. The soil is too dry if the sheepsfoot roller does not fully penetrate the soil.
- Any additional water needed for proper compaction shall be thoroughly mixed in with a disk prior to compaction.
- The surface of a compacted lift must be sufficiently moist to allow bonding with the next lift, otherwise the surface needs to be scarified, wetted to the minimum moisture content, and recompacted prior to placement of the next lift.

Lining Waste Treatment Lagoons or Settling Facilities. Determine the need for lagoon lining during the geological exploration performed by an engineering geologist or registered professional engineer. Liner criteria will be by one of these four methods:

1. Compacted soil.

Laboratory testing of soil samples (taken during the geologic exploration) will be performed to determine compaction requirements necessary to meet allowable design seepage of a recompacted clay liner.

Soil liners shall be designed using procedures in Section 651.1080 (Appendix 10 D) of the AWMFH, and Conservation Practice Standard 521-F, Pond Sealing or Lining – Compacted Earth Liner. Liners must be designed to resist uplift pressures with a minimum factor of safety of 1.1.

When liners or sealing is required, Ohio construction practice standard Pond Sealing or Lining, Compacted Earth Liner (521-F) shall be used.

2. Concrete

The minimum thickness for concrete liners is 5 inches. Use non-metallic water stops for all joints. Reinforce the concrete as per the Fabricated Structure Criteria in this practice standard. Caution should be used when designing concrete liners where uneven settlement may occur.

3. Flexible Membranes (Plastic)

Installation of flexible membranes must be supervised by the manufacturer or his/her representative and include written certification that the liner was installed as per the manufacturers recommendations. The flexible membrane, appurtenances, and installation procedures must meet NRCS Practice Standard 521a, Construction Specification 97 and Material Specification 594 (High Density Polyethylene (HDPE), Linear Low Density, Polyethylene (LLDPE), Ethylene Propylene Diene Monomer (EPDM), Poly Vinyl Chloride, (PVC), and Polypropylene (PP) flexible liner).

The design of flexible membrane liners must consider relief of hydrostatic uplift pressures and venting of entrapped gas under the liner.

4. Geosynthetic Clay Liners (GCL).

Installation of GCL must be supervised by the manufacturer or his/her representative and include written certification that the liner was installed as per the manufacturers recommendations. The flexible membrane, appurtenances, and installation procedures must meet NRCS Construction Specification 98 and Material Specification 595 (Geosynthetic Clay Liners).

Installation of GCL shall meet the following additional requirements. Placement of GCL is limited to 3:1 (H:V) slopes or flatter unless acceptable test data is available showing that stability can be achieved on steeper slopes. Provide a minimum of 1.5 ft of soil cover on the liner to protect against erosion and provide confining pressure.

The design of GCL liners must consider relief of hydrostatic uplift pressures and venting of entrapped gas under the liner.

Where recompacted earth or special liners are necessary, the cost must be considered early during project planning. Alternative livestock housing and manure handling systems should be evaluated.

Waste Production and Characteristics

The design inputs used to size the facility must be documented by one (or both) of the following:

- NRCS Animal Waste Management (AWM) computer program.
- Hand calculations referencing manure volumes from NRCS or Midwest Plan Service publications, and rainfall/ runoff volumes from NRCS publications.

However, if the landowner submits applicable livestock data for his operation, it should be used.

SINGLE STAGE LAGOON

The method for sizing is based on the Rational Design Standard for Anaerobic Livestock Lagoons. It will be required to calculate two lagoon volumes for comparison, (MTV + SV) and OCV. The first volume is based on the maximum volatile solids loading rate for minimum treatment (MTV), plus the anticipated sludge volume (SV). The second is based on the volatile solids loading rate required to control odors and is called the Odor Control Volume (OCV). Required rainfall plus annual inputs shall be added to the larger of the two volumes to arrive at the total volume of the lagoon.

Summation of annual rainfall plus annual input volumes to be added to a single stage lagoon:

1. Waste water volume.
2. Annual rainfall less evaporation
3. 25-year, 24 hour rainfall volume on the lagoon surface.
   ** With A Drainage Area (DA) Included:
4. Fifty percent of mean annual precipitation on the DA.
5. 25-year, 24 hour runoff from the DA.

The minimum treatment volume (MTV) is determined by dividing the daily volatile solids (VS) loading by the maximum volatile solids loading rate per unit volume (MLRV) times the activity ratio, K, for the location:

MTV = VS/(MLRV)(K). The following are MLRVs to be used for design:

Swine	MLRV=0.0062 lb/ft^3 -d
Dairy	MLRV=0.0105 lb/ft^3 -d
Poultry	MLRV=0.0062 lb/ft^3 -d

The minimum sludge accumulation period shall be 7 years, and should not need to exceed 10 years when sludge is managed for utilization in the CNMP. Sludge volume is based on the total solids (TS) entering the lagoon. SV = (TS/yr) x SAR x YEARS. The following are sludge accumulation ratios (SAR) to be used for design. For beef operations, use the dairy SAR for feed operations with a high forage ration, or the swine SAR for feeding operations with a high concentrate ration.

Swine	SAR=0.0485 ft^3/lb (TS)
Dairy	SAR=0.0729 ft^3/lb (TS)
Poultry	
Layers	SAR=0.0295 ft^3/lb (TS)
Pullets	SAR=0.0455 ft^3/lb (TS)

The odor control volume (OCV) is determined by dividing the daily VS loading by a standardized loading rate, (LRV), times the activity ratio, K, for the location: OCV = VS/(LRV)(K). The following are Larva's to determine odor control volumes:

Swine	LRV=0.00378 lb/ft^3-d
Dairy	The OCV for dairy and beef lagoons shall be equal to the MTV
Poultry	LRV=0.00253 lb/ft^3-d

Lagoon activity ratios (K), are based on lagoon reaction rates throughout the United States. Ohio counties are listed at the end of Chapter 10 in the AWMFH (pages OH10-86-87).

TWO STAGE LAGOON (sizing)

First Stage

(MTV + SV) or OCV, whichever is greater.

Second Stage (The summation of the following.)

1. MTV (Based on VS loading at the overflow or estimates of the VS loading from the first stage effluent.)
2. Annual manure volume.
3. Waste water volume.
4. Annual rainfall less evaporation (figured from the lagoon surface of stage 1 and stage 2.)
5. 25-year, 24-hour rainfall from the lagoon surface of stage 1 and 2.
   ** With A Drainage Area (DA) Included:
6. Fifty percent of mean annual precipitation on the DA.
7. 25-year, 24-hour runoff from the DA.

Depth, Bottom, and Shape

The embankment is limited to 25 ft. or less, as measured from the lowest point on the centerline of the earthfill, to the top of the embankment. The design height of the embankment shall be increased by the amount needed to ensure that the design top elevation is maintained after settlement. This increase shall not be less than 5 percent. The minimum top width shall be as follows:

Embankment Height (ft)	Minimum Top Width (ft)
<15	8
15-20	10
20-25	12

When the embankment will be crossed by farm equipment, the minimum top width is 12 ft. Agitation areas should have a minimum top width of 20 ft. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical. The steepest side slope shall be 2:1. The minimum elevation of the top of the settled embankment shall be 1 ft. above the maximum design water surface in the lagoon. Riprap on the inside slope should be a consideration where the reach across the lagoon exceeds 300 ft. into the prevailing wind. This situation usually causes bank erosion unless other means are used to curtail the wind.

Inlet

If freezing is not a problem, an open inlet such as a concrete channel may be used. If freezing is a problem, the inlet shall consist of a pipe having a minimum diameter of 6 in. and a minimum slope of 1 percent, except that a minimum diameter of 4 in. may be used for milking center waste. The inlet pipe shall be a minimum 4-ft. below the normal liquid level or a justified level to prevent freezing. The lagoon slope below the inlet shall be protected from erosion. Cleanouts shall be placed at 100 ft. or less. To prevent gases from entering buildings a water-sealed trap and vent or similar device shall be provided on pipelines leaving enclosed buildings discharging to enclosed settling tanks. Inlet lines shall be of material that will not separate at the joints, that will be watertight, and that can withstand sunlight, weather, earth and traffic loading.

Protection

Fencing the lagoon and providing flotation devices for public safety shall be at the discretion of the landowner. If there is a possibility that small children will play or have access to the lagoon, it is recommended that the lagoon be fenced. The lagoon poses a similar risk for loss of life as does a farm pond. Warning signs with a rope and safety flotation device shall be placed on at least two sides of the lagoon. Livestock shall be fenced from the embankment and the lagoon. If the lagoon is fenced, follow the fencing requirements in the Ohio Conservation Practice Standard 382, Fencing, with the following additional requirements:

- Barbed wire fencing requires a minimum of 5 strands.
- The bottom of any fence can be no more than 10 inches off the ground.

It is recommended that vegetative screens, flowers, shrubs, trees, or other methods, be used to shield the lagoon from public view and improve the aesthetics.

Emergency Spillways and Overflow Pipes

Lagoons shall not be required to have an emergency spillway or an overflow pipe. If an emergency spillway or overflow pipe is used, the crest of the emergency spillway or the invert of the overflow pipe shall be at least 1 ft. below the top of the settled embankment. The emergency spillway, if used, shall have a minimum bottom width of 4 ft. and capacity to carry the 25-year, 24-hour runoff. The emergency overflow pipe, if used, shall have a minimum diameter of 6 in.

Freeboard

All lagoons shall be required to have 1-ft. freeboard unless otherwise dictated by Ohio law.

Measuring Post or Markers

A measuring post or equivalent shall be placed in the lagoon indicating the following:

1. The required precharge depth prior to loading.
2. The dewatering depth.
3. The odor control volume depth.
4. The maximum liquid depth.

CONSIDERATIONS

Permits

The owner or operator shall be responsible for securing all required permits or approvals and for performing in accordance with such laws or regulations. NRCS employees are not to assume responsibility for procuring these permits, rights or approvals, or for enforcing laws and regulations. NRCS may provide the landowner or operator with technical information needed to obtain the required permits, rights or approvals to construct, operate or maintain the practice.

Settling Facility

Settling facilities will extend the life of the lagoon by decreasing sludge accumulation. It is recommended that structures used as settling facilities have at least 7 days of storage. Earthen settling facilities shall have enough capacity to settle solids between cleanouts. Six months manure solids capacity is recommended for waste storage ponds used as settling facilities.

An alternative design to a single or two stage lagoon is the Anaerobic Lagoon / Settling Basin. The Anaerobic Lagoon / Settling Basin is designed to hold the majority of total and volatile solids in the settling basin which significantly reduces the lagoon loading and resulting size. The system will typically be designed for an operator who wants to utilize the nutrient value of the manure and have recycled water available for flushing. The planning and design procedures for this system can be found as an Ohio supplement to the AWMFH (pages OH10-88-91).

Precharging

Filling the lagoon to the specified level with fresh water prior to the beginning of loading with waste is critical. The bacterial populations must be given the proper environment to grow and flourish. The precharge volume creates this environment. The landowner must realize the fresh water requirements and locate an adequate fresh water source prior to design. For instance, a 1,000 swine finishing unit will require a precharge volume of 1.4 million gallons of fresh water prior to loading. Filling the lagoon at 5 gallons per minute will take 6.6 months to reach the precharge volume if no seepage occurs.

If the lagoon is not sufficiently precharged before wastewater is introduced, it will not properly function as a treatment facility, resulting in odor production. If this occurs, the lagoon will most likely need to be completely emptied and restarted with the proper precharge volume. This would be difficult once the buildings are in production.

These facts must be taken into consideration and a plan for precharging decided on by the landowner.

Dewatering and Sludge Removal

There are two alternatives for managing sludge in a lagoon. Let the sludge accumulate over the accumulation period, or try to decrease the sludge accumulation by dewatering from the bottom of the lagoon. To put this into perspective, an anaerobic lagoon designed for 1,000 finish hogs will accumulate 28 tons of Total Nitrogen (TKN) and 24 tons of phosphorous (P) over a 20-year accumulation period. Sludge management decisions must be made by the landowner, placed in the O&M plan, and made part of the CNMP.

It is recommended that sludge be removed and managed on an annual basis, and planned for in the CNMP to increase the functional design life of the lagoon. Dewatering from the bottom from several locations in the lagoon or lagoon agitation can accomplish this. There is some evidence that sludge may accumulate on the leeward side of the lagoon. Measuring the sludge at the bottom of the lagoon is a way of monitoring sludge accumulation. It is recommended that sludge accumulation initially be measured and recorded every three to five years, then more frequently as sludge production increases as the lagoon ages. Sludge measurements should be taken during the cold months, since the sludge will be most stable, and give the most accurate results. Barth does suggest a design for a sludge measuring device in his sludge characteristics paper listed in the references.

Once the sludge volume (SV) has been filled, accumulated sludge must be removed for the lagoon to continue to function as a treatment facility. As accumulated sludge begins to displace the MTV, the lagoon will begin to fail, resulting in odor production. Recovery from this type of failure will require the entire lagoon volume to be removed, and the lagoon be reestablished with a fresh water precharge as described above and in the O&M section of this standard.

Loading

Loading any type of lagoon should be done on a continuous basis. Anaerobic lagoons will tolerate loading every other day, but daily loading is preferred. Slug loading, as from pumping from an underground pit into the lagoon, will shock the lagoon from which it may not recover and will cause odor problems.

PLANS AND SPECIFICATIONS

Plans and specifications for installing waste treatment lagoons shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Precharging

Prior to waste loading, the first stage shall be precharged to the volume for minimum treatment (MTV) with fresh water. From this point, fresh water, which may include wastewater, shall be added until the lagoon is filled to the Odor Control Volume (OCV) except for dairy operations that are only precharged to the MTV. This shall be accomplished as soon as is practical, but no later than the first year of operation. This is the minimum requirement. It is recommended to precharge the lagoon with fresh water to the OCV prior to loading particularly in instances where residences are located within a quarter mile down wind.

Dewatering

Dewatering shall occur minimally on an annual basis. The volume of liquid to be dewatered is equivalent to the annual inflow. This will vary due to differences in rainfall, evaporation, wastewater, etc.

Single stage anaerobic lagoons shall be dewatered to the depth or elevation equivalent to the design volume minus the annual inputs.

The second stage of a two-stage anaerobic system shall be dewatered to the depth or elevation associated with the MTV in the second stage. If the first stage of a two-stage system is dewatered, that water shall be replaced from the second stage.

In order to obtain satisfactory performance of waste treatment lagoons, they must be carefully managed. The O&M plans for lagoons shall include:

1. Precharging requirements.
2. Loading Rates.
3. Dewatering
4. Sludge Management
5. Odor Management
6. Embankment (stability, vegetative management, rodent control)
7. Measuring Post
8. Gravity Flow Pipelines
9. Safety
10. Special Considerations

Facility Closure. Facility closure, usually due to abandonment, requires a site-specific closure and inspection plan. Obtain all required permits prior to the closure operation. Address or include the following items in the closure plan.

- A copy of the facility's "As Built Plans".
- A copy of the facility's geological exploration.
- Removal and utilization of solids and liquids as per NRCS Field Office Technical Guide, Section IV, Ohio Conservation Practice Standard 633, Waste Utilization.
- Contaminated soil removal and utilization.
- Method of disposal or burial of fabricated structures, liners, covers, and other appurtenances.
- Removal or plugging of all transfer systems.
- The type of material and method of filling the facility.
- The grading plan and erosion control measures.
- If applicable, conversion of the facility or facilities for other purposes.
- The timing and amount of inspection required.
- Any tests required for closure.

APPENDIX

Aquifer. A geologic unit, soil or rock, that can store, transmit, and yield a significant amount of water to a well or spring. Except in extreme unusual circumstances, aquifers can yield a minimum of 5 gpm for a considerable length of time. The upper boundary of most aquifers is usually below 25 ft of depth and separated from the ground surface by material of low hydraulic conductivity. In some areas the depth to the top of an aquifer may be less than 25 feet.

The upper surface of a zone of saturated water within soil or rocks is known as the water table. Water tables can be "perched" or elevated due to a less permeable material below them, or the water table may lie at the top surface of an aquifer.

The following conditions do not constitute an aquifer: 1) pore spaces within unsaturated soil that contain water. 2) A perched water table that allows small amounts of water to move continuously through the soil. 3) A perched water table that allows moderate amount of water to move into an open pit for some time and then stop.

REFERENCES

Control of Manure Odors, ASAE, Engineering Practice EP379.

Livestock Waste Lagoon Sludge Characterization. Clyde Barth and Jelly Kroes. Agricultural Waste Utilization and Management, Proceedings of the Fifth International Symposium on Agricultural Waste. American Society of Agricultural Engineers. St. Joseph, MI pp. 660-671

The Rational Design Standard for Anaerobic Livestock lagoons, Clyde Barth, Agricultural Waste Utilization and Management, Proceedings of the Fifth International Symposium on Agricultural Waste. American Society of Agricultural Engineers, St. Joseph, MI p 638-647.

The Agricultural Waste Management Field Handbook and Animal Waste Management (AWM) design program:
http://www.oh.nrcs.usda.gov/technical/engineering/engineering_software.html

National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook, Ohio Issue 1; Chapter 7 - Geology and Groundwater Considerations, and Chapter 10 - Anaerobic Lagoon design "K" values, and Anaerobic Lagoon/Settling Basin (ALSB) design procedure
http://www.oh.nrcs.usda.gov/technical/engineering/references/awmfh_suppl.html

Drastic Maps for selected counties are available from ODNR; information about the maps is available by calling (614) 265-6740, or on-line at:
http://www.dnr.state.oh.us/water/pubs/fs_div/fctsht09.htm

Water well logs from ODNR, Division of Water, can be located on-line at:
http://www.dnr.state.oh.us/water/maptechs/wellogs/app/default.asp

County Ground Water Resource maps are available from ODNR, information on map is available by calling (614) 265-6740, or on-line at:
http://www.dnr.state.oh.us/water/pubs/fs_div/fctsht10.htm

Information about Ohio EPA's Source Water Assessment and Protection Program (SWAP) and Sole Source Aquifers is available at:
http://www.epa.state.oh.us/ddagw/pdu/swap.html

NRCS drawing and design reference Web Sites:

Ohio NRCS Standard engineering drawings:
http://www.oh.nrcs.usda.gov/technical/engineering/cadd2.html

Ohio conservation practice standards (e-FOTG):
http://www.oh.nrcs.usda.gov/technical/ohio_eFOTG.html

NRCS Ohio Construction Specification - Concrete:
http://www.oh.nrcs.usda.gov/technical/engineering/neh20.html

Ohio technical references- general link:
http://www.oh.nrcs.usda.gov/technical/engineering/references/tech_refs.html