

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**WASTE TREATMENT LAGOON**

(No.)

**CODE 359**

**DEFINITION**

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

**PURPOSE**

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

**CONDITIONS WHERE PRACTICE APPLIES**

- Where the lagoon is a component of a planned agricultural waste management system
- Where treatment is needed for organic wastes generated by agricultural production or processing
- On any site where the lagoon can be constructed, operated, and maintained without polluting air or water resources
- To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads

**CRITERIA**

**General Criteria for All Lagoons**

**Laws and Regulations.** All federal, state, and local laws, rules, and regulations governing the construction and use of waste treatment lagoons must be followed.

**Location.** To minimize the potential for contamination of streams, lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and 25-year, 24-hour storm event runoff shall be included in the required volume of the lagoon.

**Soils and Foundation.** The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulations, or the lagoon shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in AWMFH, Chapter 10, Appendix 10D.

The lagoon shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, lagoon seepage rates, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains to meet this requirement.

**Soil Amendments.** Soil amendments may be used to create a clay liner with the required permeability.

Soil amendments shall meet or exceed the requirements of Pond Sealing or Lining, Soil Dispersant (521B) or Pond Sealing or Lining, Clay Liner (521D).

**Flexible Membranes.** Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in Pond Sealing or Lining, Flexible Membrane (521A).

**Required Volume.** The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events
- Minimum treatment volume (anaerobic lagoons only)
- Volume of manure, wastewater, and other wastes accumulated during the treatment period
- Depth of normal precipitation less evaporation on the surface area (at the required volume level) of the lagoon during the treatment period
- Depth of the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon

**Treatment Period.** The treatment period is the detention time between drawdown events. It shall be the greater of either 60 days; or the time required to provide the storage that allows environmentally safe utilization of waste considering the climate, crops, soil, and equipment requirements; or as required by federal, state, and local regulations.

**Waste Loading.** Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Reliable local information or laboratory test data should be used if available. If local information is not available, AWMFH, Chapter 4 may be used for estimating waste loading.

**Embankments.** The minimum elevation of the top of the settled embankment shall be 1 foot above the lagoon's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1.

The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

**Table 1 – Minimum Top Widths**

Total Embankment Height, feet	Top Width, feet
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

**Excavations.** Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

**Inlet.** Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and ultraviolet ray deterioration, while incorporating erosion protection as necessary. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces. The minimum diameter pipe used will be 4-inch for settled wastewater or milk barn drains and 6-inch for unsettled wastewater.

**Outlet.** Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon. Lagoons having a maximum design liquid level of 3 feet or more above natural ground line shall be provided with an emergency spillway to prevent overtopping. The emergency spillway, when used, shall have a minimum bottom width of 4 feet.

**Facility for Drawdown (Pump down).** Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc., shall permit drawdown without causing erosion or damage to liners.

**Sludge Removal.** Provisions shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon. Removal methods must not damage liners.

**Erosion Protection.** Embankments and disturbed areas surrounding the lagoon shall be treated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner. The outer slopes will be seeded with grasses according to Critical Area Planting (342).

**Safety.** The design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted to prevent children and others from using it for other than its intended purpose.

#### **Additional Criteria for Anaerobic Lagoons**

**Loading Rate.** Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per unit of volume. The maximum loading rate shall be as indicated in AWMFH, Chapter 10, Figure 10-22, or according to state regulatory requirements, whichever is more stringent.

**Operating Levels.** The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon. The maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

**Depth Requirements.** The minimum depth at maximum drawdown shall be 6 feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum drawdown, a lesser depth may be used, if the volume requirements are met.

#### **Additional Criteria for Naturally Aerobic Lagoons**

**Loading Rate.** Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD<sub>5</sub> loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown.

The maximum loading rate shall be as indicated by AWMFH, Chapter 10, Figure 10-25, or according to state regulatory requirements, whichever is more stringent.

**Operating Levels.** The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event on the lagoon surface. The maximum drawdown level shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

**Depth Requirements.** The minimum depth at maximum drawdown shall be 2 feet. The maximum liquid level shall be 5 feet.

#### **Additional Criteria for Mechanically Aerated Lagoons**

**Loading Rate.** Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD<sub>5</sub> loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD<sub>5</sub> loading.

**Operating Levels.** The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

### **CONSIDERATIONS**

#### **General**

Lagoons should be located as close to the source of waste as possible.

Solid/liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal and method of sealing.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

**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 embankment failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments:

- An auxiliary (emergency) spillway
- Additional freeboard
- Storage volume for the wet year rather than normal year precipitation
- Reinforced embankment -- such as, additional top width, flattened and/or armored downstream side slopes
- Secondary containment
- Water level indicators or recorders

The following should be considered to minimize the potential for accidental release from the required volume through gravity outlets:

- Outlet gate locks or locked gate housing
- Secondary containment
- Alarm system
- Another means of emptying the required volume

**Considerations for Minimizing the Potential of Lagoon Liner Seepage**

Consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed in Table 2 may be affected.

**Table 2 – Potential Impact Categories for Liner Seepage**

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| <ol style="list-style-type: none"> <li>1. Any underlying aquifer is at a shallow depth and not confined.</li> <li>2. The vadose zone is rock.</li> <li>3. The aquifer is a domestic water supply or ecologically vital water supply.</li> <li>4. The site is located in an area of carbonate rock (limestone or dolomite).</li> </ol> |
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Should any of the potential impact categories listed in Table 2 be affected, consideration should be given to the following:

- A clay liner designed in accordance with procedures of AWMFH, Chapter 10, Appendix 10D, with a thickness and coefficient of permeability so that specific discharge is less than  $1 \times 10^{-6}$  cm/sec
- A flexible membrane liner
- A geosynthetic clay liner (GCL) flexible membrane liner
- A concrete liner designed in accordance with slabs on grade criteria Waste Storage Facility (313) for fabricated structures requiring water tightness

**Considerations for Improving Air Quality**

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

- Reduce the recommended loading rate for anaerobic lagoons to one-half the values given in AWMFH, Chapter 10, Figure 10-22.
- Use additional practices such as Anaerobic Digester – Ambient Temperature (365), Anaerobic Digester – Controlled Temperature (366), Waste Facility Cover (367) and Composting Facilities (317) in the waste management system.
- Liquid/solid separation prior to discharge to lagoon will reduce volatile solids (VS) loading resulting in reduced gaseous emissions and odors. Composting of solids will further reduce emissions.

- Design lagoons to be naturally aerobic or to allow mechanical aeration.

Adjusting pH below 7 may reduce ammonia emissions from the lagoon but may increase odor when waste is surface applied. (See Waste Utilization (633))

## PLANS AND SPECIFICATIONS

The following list of Construction Specifications is intended as a guide to selecting the appropriate specifications for a specific project. The list includes most, but may not contain all, of the specifications needed for a specific project:

IA-1	Site Preparation
IA-3	Structural Removal
IA-5	Pollution Control
IA-6	Seeding and Mulching for Protective Cover
IA-11	Removal of Water
IA-21	Excavation
IA-23	Earthfill
IA-24	Drainfill
IA-26	Salvaging and Spreading Topsoil
IA-27	Diversions
IA-31	Concrete
IA-32	Concrete for Nonstructural Slabs
IA-45	Plastic (PVC, PE) Pipe
IA-81	Metal Fabrication and Installation
IA-83	Timber Fabrication and Installation
IA-92	Fences

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

## OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be developed that is consistent with the purpose of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with the least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation.

This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

## REFERENCES

USDA-NRCS, National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH)

Livestock Waste Facilities Handbook, (MWPS-18), Midwest Plan Service