

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.

Swine production facilities with a steady state live weight greater than 1,000,000 pounds require protection from the 50-year, 24-hour storm storm.

Specific siting criteria is located in South Carolina Regulation 61-43: Standards for the Permitting of Animal Agriculture Facilities (SCDHEC, 2002)

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 the Agricultural Waste Management Field Handbook (AWMFH), 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. These designs require special approval by SCDHEC.

All lagoons and storage ponds shall be provided with a liner, designed with an initial specific discharge rate of less than 0.0156 feet/day. Lagoons at swine facilities shall be lined with either a natural liner or a geomembrane liner or a combination thereof. Lagoons and manure storage ponds at large swine facilities with 1,000,000 pounds or more normal production live weight or at facilities within delineated source water protection areas or vulnerable recharge areas, as determined by the Department, shall be lined with a geomembrane liner such that the vertical hydraulic conductivity does not exceed 5×10^{-7} cm/sec.

Flexible Membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in Pond Sealing or Lining, Flexible Membrane (code 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 local, state, and Federal 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 Chapter 4 of the AWMFH 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, ft.	Top Width, ft.
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.

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.

Facility for Drawdown. 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. Provision shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon.

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.

Safety. 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 Figure 10-22 or according to state regulatory requirements, whichever is more stringent. If the lagoon will be used to supply water for a recycle system the loading rate shall be limited to five (5) pounds of volatile solids per 1000 cubic feet per day (Barker and Driggers, 1985).

The minimum treatment volume and operating level may also be determined using the Ration Design Method (Barth, 1985). AWMFH, South Carolina Supplement 3 demonstrates the RDM (AWMFH, SC-3, 2003).

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 or the 50-year, 24-hour storm event

precipitation in the case of swine facilities with greater than 1,000,000 pounds SSLW.. 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 BOD₅ 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 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 BOD₅ 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 BOD₅ 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

<p align="center">Table 2- Potential Impact Categories from Breach of Embankment or Accidental Release</p> <ol style="list-style-type: none"> 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
--

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 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:

- 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 when one or more of the potential impact categories listed in Table 2 may be significantly affected:

- 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 3 may be affected.

Should any of the potential impact categories listed in Table 3 be affected, consideration should be given to the following:

- A clay liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that initial specific discharge is less than 0.0156 ft/day (SCDHEC, 2002)
- 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 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 (code 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, code 633).

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in

Table 3 - Potential Impact Categories for Liner Seepage

1. Any underlying aquifer is at a shallow depth and not confined
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 carbonate rock (limestone or dolomite)

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 plan shall be developed that is consistent with the purposes 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 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

AWMFH. 1992. Agricultural Waste Management Field Handbook. NEH – Part 651. USDA-NRCS. Washington, D.C.

AWMFH SC 3. 2003. Design of Anaerobic Treatment Lagoons. Agricultural Waste

Management Field Handbook. NEH – Part 651. USDA-NRCS. Columbia, SC.

Barker, J.C. and L.B. Driggers. 1985. Pit Recharge System for Managing Swine Underfloor Manure Pits. In: Agricultural Waste Utilization and Management, Proceedings of the Fifth International Symposium on Agricultural Wastes, pp 575-581, ASAE St. Joseph, MI 49085-9659 USA.

Barth, C.L. 1985. The Rational Design Standard for Anaerobic Livestock Lagoons.

In: Agricultural Waste Utilization and Management, Proceedings of the Fifth International Symposium on Agricultural Wastes, pp 638-647, ASAE St. Joseph, MI 49085-9659 USA.

SCDHEC. 2002. Regulation 61-43. Standards for Permitting of Animal Agricultural Facilities. South Carolina Department of Health and Environmental Control. Columbia, SC.