

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.

This standard does **not** apply to treatment of untreated human waste.

**CRITERIA**

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

Laws and regulations of particular concern include those involving county zoning, water and drainage rights, land use, land disturbance by construction, pollution control, property easements, wetlands, preservation

of cultural resources, and endangered species.

Where South Dakota Department of Environment and Natural Resources (SD DENR) approval is to be obtained, DENR requirements must be met.

South Dakota dam safety requirements shall be met for construction of facilities utilizing embankments.

The owner or operator shall be responsible for securing all required permits or approvals related to waste treatment, and for operating and maintaining any components in accordance with applicable laws and regulations.

**Location.** Waste treatment lagoons shall not be located within the 100-year frequency flood plain unless the structure is protected from inundation and damage that may occur during the 100-year frequency flood event.

Lagoons or manure and wastewater disposal sites cannot be located closer than 1,000 feet from an existing public water well or drinking water source nor 250 feet from a well or drinking water source not owned by the producer.

Lagoons or manure and wastewater disposal sites shall not be located closer than 150 feet from a water well or drinking water source that is owned by the producer.

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

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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 the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The lagoon shall have a bottom elevation that is a minimum of two 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.

**Clay Liners.** Clay liners must be at least 18 inches thick and compacted to at least 95 percent of standard maximum dry unit weight (standard proctor density), and at water content within 2 percent of optimum as determined by ASTM D698. Where SD DENR approval will be obtained, the compacted clay liner must meet South Dakota regulatory requirements.

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

**Groundwater Monitoring.** Where waste storage facilities are located over shallow aquifers or where discharge to groundwater may occur, regularly sampled groundwater monitoring wells or a Groundwater Discharge Permit may be required. For each affected site, these requirements will be as specified by the SD DENR.

**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;

For exposed lagoons, depth of mean annual precipitation less evaporation on the surface area inside the tops of the containment dikes.

Mean annual runoff (if the structure receives runoff from an open lot or other drainage area);

For lagoons containing waste from swine, poultry or veal, include the depth of the 100-year frequency, 24-hour duration storm precipitation on the surface area inside the tops of the containment dikes.

For other waste, include the depth of the 25-year frequency, 24-hour duration storm precipitation on the surface area inside the tops of the containment dikes.

For lagoons containing waste from swine, poultry or veal, include the 100-year frequency, 24-hour duration precipitation runoff (if the structure receives runoff from an open lot or other drainage area).

For other waste, include the 25-year frequency, 24-hour duration precipitation runoff (if the structure receives runoff from an open lot or other drainage area);

Additional storage as may be required to meet management goals or regulatory requirements.

The minimum elevation of the top of the settled embankment shall be one foot above the lagoon's required volume. Minimum freeboard for facilities permitted by SD DENR must meet state regulations.

Uncontaminated storm water runoff shall be diverted away from the waste treatment facility wherever appropriate. Structures designed to divert runoff must be designed to divert the peak flow expected during the 25-year frequency, 24-hour duration precipitation event, except where the lagoon includes waste from swine, poultry or veal, the peak flow expected during the 100-year frequency, 24-hour duration precipitation event must be diverted.

**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 one foot above the lagoon's required volume. Minimum freeboard for facilities permitted by SD DENR must meet state regulations. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. Where required compaction is less than 95 percent of ASTM D698 standard maximum dry unit weight (standard proctor density,) the fill height increase for settlement shall not be less than 5 percent. Earth embankment slopes must be designed to be stable, and must be 3 horizontal to 1 vertical or flatter.

Minimum top widths are shown in Table 1.

<b>Total Embankment Height at Centerline, feet</b>	<b>Top Width, feet</b>
9.9 or less	8
10–19.9	10
20–24.9	12
25–29.9	14
30–35	15

Note – SD DENR may require other widths.

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

**Wind and Wave Protection.** Erosion protection shall be provided for earthen waste treatment lagoons having a five-acre or larger liquid surface at maximum operating level.

**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.

For inlets carrying solids, the inlet should be designed to deposit waste near the center of the side of the lagoon or storage area. Minimum pipe diameter shall be 10 inches except as recommended by equipment manufacturers. The preferred pipe slope for gravity flow is one percent. Flatter slopes may be used where provision is made to clear blockages.

**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. 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.

**Safety.** Designs shall include appropriate safety features to minimize the hazards of the facility. Warning signs, fences, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock.

#### **ADDITIONAL CRITERIA FOR ANAEROBIC LAGOONS**

**Loading Rate.** Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids 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.

**Operating Levels.** The maximum operating level shall be the lagoon level that provides the required volume less the included storm event precipitation on the surface of the lagoon. Maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus sludge volume accumulated between sludge removal events. Permanent markers shall be installed at these elevations, and referenced and described in the operation and maintenance plan. Proper operating range of the lagoon is above maximum drawdown level and below maximum operating level.

**Depth Requirements.** The minimum depth at maximum drawdown shall be six 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 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 included 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 sludge volume accumulated between sludge removal events. Permanent markers shall be installed at these elevations, and referenced and described in the Operation and Maintenance (O&M) Plan. Proper operating range of the lagoon is above maximum drawdown level and below maximum operating level.

**Depth Requirements.** The minimum depth at maximum drawdown shall be two feet. The maximum liquid level shall be five 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 one 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 included storm event precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation and referenced and described in the O&M Plan. 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.

#### **CONSIDERATIONS**

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/mitigate embankment failure or accidental release risks/impacts should be considered when any of the categories listed in Table 2 may be significantly affected. Consider including:

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;
- Outlet gate locks or locked gate housing;
- Alarm system;
- Another means of emptying the volume.

<b>Table 2 – Potential Impact Categories from Breach of Embankment or Accidental Release</b>
Surface water bodies - perennial streams, lakes, wetlands, and estuaries.
Critical habitat for threatened and endangered species.
Riparian areas.
Farmstead or other areas of habitation.
Off-farm property.
Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

**CONSIDERATIONS FOR MINIMIZING THE POTENTIAL OF LAGOON LINER SEEPAGE**

Consider providing additional safety from lagoon seepage when conditions listed in Table 3 exist. Consider including:

- A clay or flexible membrane liner;
- A concrete liner.

<b>Table 3 – Potential Impact Categories for Liner Seepage</b>
Any underlying aquifer is at a shallow depth and not confined;
The vadose zone is a rock;
The aquifer is a domestic water supply or ecologically vital water supply;
The site is located in an area of carbonate rock (limestone or dolomite).

**CONSIDERATIONS FOR IMPROVING AIR QUALITY**

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

Reduce the loading rate for anaerobic lagoons to one-half the values given in AWMFH, Figure 10-22.

Use additional practices such as Anaerobic Digester (365 or 366,) Waste Facility Cover (367,) and/or Composting Facilities (317).

Use liquid/solid separation. Compost solids; treat liquids in the lagoon.

**Aerate the lagoons.**

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**

Plans and specifications shall meet this standard and shall include requirements needed to achieve its purpose.

**OPERATION AND MAINTENANCE**

An O&M Plan must be developed for use by the owner/operator. 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**

South Dakota Department of Environment and Natural Resources (DENR) references.

Animal Waste Management to Protect Water  
Quality (EC 895) – South Dakota  
Cooperative Extension Service.

Livestock Waste Facilities Handbook  
(MPWS-18) Midwest Plan Service.

Concrete Manure Storages Handbook  
(MWPS-36) Midwest Plan Service.