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

Types. Waste treatment lagoons are of three general types: anaerobic, naturally aerobic, and mechanically aerated. Each type may be employed separately or in combination with another. Anaerobic lagoons require less surface area than naturally aerobic lagoons but may give off odors.

Naturally aerobic lagoons are relatively odor free. Mechanically aerated lagoons are comparable in size to anaerobic lagoons and generally odor free, but they require energy for aeration and cost more to operate.

Recirculation. Animal holding areas and waste collection gutters may be flushed and washed down with water recycled from a lagoon. Lagoon recirculation pumps used to recycle flush water should be located as far from effluent inlets as possible. Pumps and recycle lines shall be protected from freezing.

Solids removal. To reduce sludge buildup, remove solids from waste of animals such as dairy cattle fed high roughage rations. A solids trap or a separator may be provided between the waste sources and the lagoon. This may be a concrete or earth structure that can be emptied periodically. If earth structures are used, a minimum of two cells should be planned so that one can be dried and cleaned while the other is functioning. At dairy operations, solids must be removed at least every 7 days, taken from the site, and spread on land.

Location. Any facility for the treatment or disposal of animal wastes or the housing of a concentrated and confined animal growing operation (excluding any facility for the housing of broiler pullets, broiler breeders and broilers in a poultry operation that generates dry litter or waste unless such facility has a continuous overflow watering system) must be at least 1000 feet from the nearest unowned (by the applicant) occupied dwelling or commercial establishment and at least 300 feet from the nearest adjoining property line. Any facility for the housing of broiler pullets, broiler breeders and broilers in a poultry operation that generates dry litter or waste constructed, enlarged or significantly altered after February 24, 1994, (date of adoption of these regulations) must be at least 600 feet from the nearest unowned (by the applicant) occupied dwelling or commercial establishment and at least 150 feet from the nearest adjoining property line. The lagoon shall be no closer than 150 feet from a water supply.
well. Dairy lagoons shall be no closer than 100 feet from the milk room or milk parlor.

The lagoon should be located near the source of waste, if possible, located where prevailing winds will carry odors away from residences and public area. The lagoon should also be located for ease in waste distribution and land application. 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.

**Compliance.** All laws, rules, and regulations governing the design, construction, operation, and maintenance of waste treatment and disposal systems shall be strictly adhered to. Construction of a lagoon shall not begin until the owner or operator has fully complied with requirements of the regulatory agencies and has received written authorization to begin such construction.

**Odor Control.** Pipes discharging wastes into the lagoon shall be extended beneath the surface of the lagoon.

Where lagoon effluent is removed by recirculation and/or land application pumps, a floating intake shall be placed 18-30 inches beneath the lagoon’s water surface.

Lagoons must be pre-charged by adding fresh water to the newly constructed lagoon to a depth of not less than 50 percent of the minimum treatment volume of the lagoon. Effluent from mature lagoons serving similar purposes may also be used for pre-charging.

Vegetative screens shall be constructed at strategic locations near spray field, lagoons, and animal holding facilities. Actual location of screens is based on topography, soils, existing screens, prevailing winds, nearby residences, and other sensitive areas. These screens should consist of approximately 25 feet of rapidly maturing trees, 15 feet of tall under-growth, and 10 feet of grasses.

Land application of effluent from a lagoon should be accomplished, as much as possible, from mid to late morning. Application should not occur at dusk or after dark and should be attended by the operator at all times. Where a high degree of odor control is required and should be minimized, weekend applications should be avoided. Unless cool season forages are present, applications should be postponed between October 1 and March 31 north of Interstate 20 and between November 1 and March 31 south of Interstate 20. The Emergency Action Plan may provide exceptions.

Spray systems shall be designed to minimize aerosols and odors by using low trajectory irrigation guns with the lowest possible acceptable nozzle design pressure while not exceeding the soil infiltration rate.

**NRCS waste management plans shall emphasize the need to measure the pH of surface liquids in anaerobic lagoons each spring. If pH falls below 6.5, a pound of hydrated lime or lye shall be added per 1,000 square feet of lagoon surface daily until the pH reaches 7.0.**

An Emergency Action Plan shall be prepared for each lagoon which outlines steps to be followed in case of an emergency such as overflow, breaching, leakage, severe weather conditions, need of emergency land application, etc.

**Design**

**Waste production.** Waste treatment lagoons are designed on the basis of 5-day biochemical oxygen demand (BOD₅) or volatile solids (VS) loading. Design loading shall be based on the average weight of animals using the lagoon and on their waste introduced. Information on waste production is provided in Chapter 4 of the Agricultural Waste Management Field Handbook (AWMFH). Reliable local determinations should be used if available.

**Loadings.** Anaerobic waste treatment lagoons are designed on the basis of daily volatile solids (VS) loading per 1,000 ft³ of lagoon volume. This loading rate is used to determine the minimum treatment volume (MTV). Maximum loading shall be as indicated in Figure 1. If a
A high degree of odor control is necessary, loading rates should be decreased.

Figure 1. Anaerobic Loading Rate (lbs. VS/1000 cf/day)

Naturally aerobic lagoons are designed on the basis of daily BOD₅ loading per acre of lagoon surface. Normally, they are employed following an anaerobic lagoon to provide a higher degree of treatment. However, for small operations where site or soil conditions limit lagoon depth, naturally aerobic lagoons may be employed separately. Single aerobic lagoons are not recommended for cattle feeding operations because the floating solids on the lagoon surface limit aerobic activity. Allowable loading rates for aerobic lagoons are provided in Chapter 10 of the AWMFH.

Mechanically aerated lagoons are designed on the basis of BOD₅ or ultimate BOD loading and on the basis of the equipment manufacturer's performance data for oxygen transfer and mixing. If used for odor control, aeration equipment shall provide a minimum of 1 lb of oxygen for each pound of BOD₅ contributed daily. For complete treatment, refer to the design procedures provided in the AWMFH.

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. A detailed soils and/or geologic investigation must evaluate soils to a depth no less than two feet below the final grade of any excavation. One test pit or soil boring is required per acre of lagoon surface. A qualified soil scientist and/or geologist shall investigate all sites. Laboratory testing shall be conducted.

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.

Flexible membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in NRCS Practice Standard 521, Pond Sealing or Lining, Flexible Membrane Lining.

Volume. The volume requirement of an anaerobic lagoon is the sum of the following volumes (see Figure 2):

- Volume of accumulated sludge for period between sludge removal events not less than 2 years. Anaerobic dairy lagoon sludge accumulates at a rate of 266 cubic feet per 1000 pounds live weight per year. Anaerobic swine lagoon sludge accumulates at a rate of 112 cubic feet per 1000 pounds live weight per year. Lagoon volumes for partial confinement operations may be prorated on the basis of confinement time. Most dairy operations fit in this category.
- Minimum Treatment Volume (MTV). This volume is needed to maintain sustainable biological activity. The volume is determined by dividing the total daily volatile solids from all sources by the volatile solids loading rate from Figure 1.
- Volume of manure and wastewater accumulated between periods of drawdown. The minimum number of days between periods of drawdown shall be 90 days.
- Depth of normal precipitation less evaporation on the lagoon surface accumulated between periods of drawdown (90-day minimum). Depth of normal precipitation less evaporation shall be based on the wettest portion of the year.
- Volume of runoff from the feedlot/watershed area accumulated between periods of drawdown (90-day minimum). Annual runoff in Mississippi from concrete surfaces is
approximately 64 percent of mean annual precipitation.
- Depth of the 25-year, 24-hour storm precipitation on the lagoon surface.
- Runoff from the 25-year, 24-hour storm.
- A minimum of 1.0 foot of freeboard is required.

Operating levels. The maximum operating level of an anaerobic lagoon shall be sufficient distance below any emergency spillway to provide storage for the 25-year, 24-hour precipitation on the lagoon surface. The maximum operating level should be marked with an appropriate staff gage set in the lagoon or by other means to indicate when drawdown is needed.

The minimum operating level of an anaerobic lagoon should normally be that level needed to provide treatment of fresh wastes but not less than 3 feet of depth. When the lagoon is drawn down to permit sludge removal from the anaerobic lagoon, dilution water must be added to restore the minimum 3-foot depth and promote continuation of treatment activity.

Discharge from a lagoon is not allowed by the Mississippi Department of Environmental Quality, Office of Pollution Control except under special conditions. Periodic drawdown (pumpout) of the lagoon will be required to provide space for additional waste inflow. Utilization of wastes and liquid removed is covered under practice standard 633, Waste Utilization.

Figure 2. Anaerobic Lagoon Volumes

Depth. The minimum design depth of liquid shall be 6 feet for mechanically aerated and anaerobic lagoons and 2 feet for aerobic lagoons. The maximum depth for mechanically aerated and anaerobic lagoons is dictated by the site and the equipment. The maximum operating depth for aerobic lagoons shall be 5 feet.

Bottom and edges. The bottom of aerobic lagoons shall be approximately level. The edges of all lagoons below the planned water line shall be constructed as steep as soil conditions permit to reduce areas of shallow water and inhibit weed growth.

Embankments. 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 for fill heights constructed with compaction equipment. For fills constructed with a dozer and track compaction, increase embankment height a minimum of 10 percent. The minimum top width shall be as shown below.

<table>
<thead>
<tr>
<th>Total height of embankment</th>
<th>Top width</th>
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<tbody>
<tr>
<td>ft</td>
<td>ft</td>
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<tr>
<td>15 or less</td>
<td>8</td>
</tr>
<tr>
<td>16-20</td>
<td>10</td>
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<tr>
<td>21-25</td>
<td>12</td>
</tr>
<tr>
<td>26-30</td>
<td>14</td>
</tr>
<tr>
<td>31-35</td>
<td>15</td>
</tr>
</tbody>
</table>
For this standard, the maximum effective height of the dam is 35 feet. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical. The minimum elevation of the top of the settled embankment shall be 1 foot above the top of 25-year, 24-hour storm volume in the lagoon.

Inlet. Transfer of wastes into a lagoon may be through a pipe, open chute, or gutter. Entrance of wastes into the lagoon should be near the middle of one side to promote distribution of wastes. The lagoon shall have a maximum length to width ratio of 3:1 unless multiple waste inlets are provided. For double cell lagoons, inlets and outlets should be separated at an optimum distance to prevent short-circuiting of treatment process.

Pipes shall be of PVC material, flow under open channel conditions, and conform to one of the following minimum specifications:

<table>
<thead>
<tr>
<th>Max. Cover Over Pipe</th>
<th>Pipe Schedule or Std Dimension</th>
<th>Applicable Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ft</td>
<td>SDR 41</td>
<td>ASTM D-2241, 3033,</td>
</tr>
<tr>
<td></td>
<td>SDR 35</td>
<td>3034</td>
</tr>
<tr>
<td></td>
<td>SDR 32.5</td>
<td>ASTM D-3034</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM D-2241</td>
</tr>
<tr>
<td>10 ft</td>
<td>SDR 26</td>
<td>ASTM D-2241, 3034</td>
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<tr>
<td></td>
<td>SCH 40</td>
<td>ASTM D-1785</td>
</tr>
<tr>
<td>15 ft</td>
<td>SCH 80</td>
<td>ASTM D-1785</td>
</tr>
</tbody>
</table>

Pipe inlets shall have a minimum diameter of 8 inches and a minimum slope of 1 percent except milking center wastes may use a 4-inch pipe. The maximum pipe slope should not exceed 15 percent. All pipe shall be laid on a positive uniform grade and shall be joined according to manufacturer's recommendations for watertight joints. Wye or tee fittings shall be placed at maximum intervals of 100 feet to facilitate cleanout of the pipe. Pipes shall extend to the inside toe of slope and discharge at or above the maximum operating level. Support spacing for pipe installed above ground shall provide continuous grade control during full pipe flow conditions. Typical support spacing is 5-7 feet. A water-sealed trap and vent or a similar device shall be provided on pipelines from enclosed buildings discharging to enclosed settling tanks to prevent gases from entering the building.

Inlet lines shall be made of PVC material that will not separate at the joints; that will be watertight; and that can withstand sunlight, weather, and earth and traffic loading.

Open chutes may be used to move waste solids scraped from feeding and loafing areas directly into the lagoon. Chutes may be placed at the edge of lagoon on the excavated or fill slope and shall conform to the following criteria:

- Concrete chute shall extend at least 10 feet (slope length) into the lagoon.
• Crest (top) of concrete slope shall discharge at or above the maximum operating level. Sites having more than 2.5 feet of waste drop to lagoon surface may consist of a vertical wall so that wastes drop on the chute at the edge of the lagoon.
• Concrete chute thickness shall be 6 inches with a 2.0-foot cutoff wall at top and bottom.
• A concrete curbing 18 inches high and 6 inches wide shall be constructed to contain the wastes being pushed.
• Chute width at top of slope will be 8 feet or blade width plus 1.0 foot.
• Sturdy posts shall be installed at the top of the chute on each side of the chute. A cable for equipment and operator safety shall be secured to and stretched between the posts.
• The scraping area leading to the concrete chute crest should have a positive grade to provide surface drainage to the lagoon.
• Chutes shall be located in the middle third of the lagoon side length to promote distribution of wastes for treatment.

Gutters may also be used to move wastes into the lagoon extending to the inside toe of slope and outlet at or above the maximum operating level. Gutters shall be at least 12 inches wide and have a safety guard rail along one side. An adjacent walkway may also be desirable. Gutter material shall be pressure-treated wood or equivalent and have adequate support for wastes, cleaning equipment, and operator. Provision shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon.

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

Outlet. Outlets from the required volume shall be designated to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon. Waste treatment lagoons shall not discharge to surface waters unless the owner determines through the state regulatory agency that such discharge will not violate established water quality standards. Lagoons having a maximum design liquid level of 3 feet or more above natural ground shall be provided with an emergency spillway to prevent overtopping. The crest of the emergency spillway shall be at least 1 foot below top of fill and located at or above the elevation of the 25 year, 24 hour storm storage. The emergency spillway shall have a minimum bottom width of 4 feet.

Erosion protection. The embankment and surrounding areas should be vegetated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner. Vegetative screens or other methods should be used to shield lagoons from public view and to improve visual conditions.

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.

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

<table>
<thead>
<tr>
<th>Table 2 – Potential Impact Categories from Breach of Embankment or Accidental Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Surface water bodies—perennial streams, lakes, wetlands, and estuaries.</td>
</tr>
<tr>
<td>2. Critical habitat for threatened and endangered species.</td>
</tr>
<tr>
<td>3. Riparian areas.</td>
</tr>
<tr>
<td>4. Farmstead or other areas of habitation.</td>
</tr>
<tr>
<td>5. Off-farm property.</td>
</tr>
<tr>
<td>6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Table 3 – Potential Impact Categories for Liner Seepage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Any underlying aquifer is at a shallow depth and not confined.</td>
</tr>
<tr>
<td>2. The vadose zone is rock.</td>
</tr>
<tr>
<td>3. The aquifer is a domestic water supply or ecologically vital water supply.</td>
</tr>
<tr>
<td>4. The site is located in an area of carbonate rock (limestone or dolomite).</td>
</tr>
</tbody>
</table>

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 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 in NRCS Practice Standard 313, Waste Storage Facility, for fabricated structures requiring water tightness.

**Considerations for Improving Air Quality**

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

• Reduce loading rates of anaerobic lagoons to at least one half the values of AWMFH Figure 10-22.
• Covering the lagoon with a suitable cover.
• Using naturally aerated or mechanically aerated lagoons.
• Using composting in conjunction with a solid waste system rather than a liquid or slurry system.
• Using an anaerobic digester and biogas capture system.

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 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.

Plans for a waste treatment lagoon submitted to the Mississippi Department of Environmental Quality, Office of Pollution Control or to the Mississippi State Department of Health for approval shall closely follow the guidelines stated in the Agricultural Waste Management Field Handbook, Part 651.0203, page 2-10. The designer should refer to the example shown in Part 651.1390 Appendix 13E. The plan shall also include a "Work Sheet for Animal Waste Treatment" (MS-ENG-359), “Waste Utilization Worksheet” (MS-ENG-633), and a map of the facility. The map shall show, as a minimum, location of the feedlots, barns, lagoons, water wells, property lines, nearest occupied dwelling
not owned by the applicant, nearest public road, section lines, and area for land application of lagoon waters.

Specifications for construction and installation of waste treatment lagoons shall use or be in conformance with requirements of the attached "Construction Specifications". Any variation from these specifications shall be approved by an engineer.

**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.
Attachment 1
Anaerobic Waste Treatment Lagoon Operation and Maintenance

1. **Startup.** Fill the lagoon with water to a minimum depth of 3 feet prior to adding waste to the lagoon. This allows dilution of wastes, treatment to begin, and reduces flies and odors. The 3-foot minimum level should be maintained following pumpout operations also.

2. **Loading.** Load the lagoon with waste as frequently as possible (preferably daily) to minimize odor problems and maintain treatment efficiency of the lagoon.

3. **No discharge requirements.** The Office of Pollution Control prohibits discharge from a lagoon, except for storm event exceeding the 25-year, 24-hour frequency. To prevent discharge, accumulated lagoon wastewater must be applied to the land.

4. **Embankment maintenance.** Maintain sufficient vegetative cover on embankments to prevent erosion. Control woody vegetation by mowing. Do not allow trees to grow in the embankment or at the water's edge.

5. **Inlets and outlets.** Maintain pipes, chutes, and gutters by replacing piling and rotten lumber and repairing broken pipes as needed. Clean inlets frequently to remove deposits of manure, soil, or other solids. Protect wooden components and PVC pipe from fire.

6. **Vector control.** Control fly breeding by washing all manure from lots and buildings into the lagoon. If mosquitoes become a problem, control mosquito breeding on the lagoon surface by applying a larvacide. Controlling vegetation at the water's edge reduces mosquito breeding.

7. **Safety.** Fence lagoons to prevent humans or livestock from falling into the lagoon. Post signs warning of the deep and contaminated water. Provide and maintain curbs, guardrails, and safety stops to prevent a tractor from slipping or rolling into the lagoon (particularly important for chutes and gutters).

8. **Sludge removal.** Wastes entering a lagoon are not completely biodegradable. A sludge layer will form on the lagoon bottom. The rate of buildup of sludge will depend on the type of feed, the amount of sand and other inert material brought in by the animals, and the loading rate of the lagoon. Sludge removal should be done at least every 5 years to maintain good lagoon treatment efficiency.

9. **Floating material.** Minimize the amount of bedding or other floating material entering the lagoon. A continued buildup of floating material will shorten the life of the lagoon. Floating mats can be beneficial if odor is a problem but excessive vegetation on the lagoon surface should be avoided.
Natural Resources Conservation Service  
Construction Specification  
WASTE TREATMENT LAGOON

1. **SCOPE**

Work shall consist of constructing the waste treatment lagoon including the embankment, inlet pipes, pipe supports, concrete chutes, and needed fence to the lines and grades as shown on the drawings or as staked in the field. The location of the waste treatment lagoon shall be as shown on the furnished drawings or as staked in the field.

2. **SITE PREPARATION**

All trees, brush, vegetation, and debris to include old fence, stumps, building materials, and barnyard waste products shall be removed from the area to be occupied by the lagoon and embankment. All brush, wastes, and other debris shall be removed from the lagoon area and disposed of by burning, burying, or removal from the area.

3. **EARTHFILL**

Earthfill materials shall be obtained from the lagoon bottom or an adjacent or near by borrow area and shall be free from objectionable materials such as brush, roots, rock, or debris that would prevent construction of a relatively impermeable embankment. Topsoil should be stockpiled and spread over the embankment surface and borrow areas to facilitate revegetation.

Any rock, sand, or other permeable material exposed in the excavated lagoon surface shall be undercut by at least 12 inches and backfilled with compacted clay material.

Fill shall be placed against slopes no steeper than 2:1 and in lifts no greater than 9 inches thick. Compaction shall be accomplished by routing the hauling and spreading equipment over the fill in such a manner that every point on the surface of each layer of fill will be traversed by not less than one tread track of the equipment or as specified in the construction details.

The embankment, borrow areas, and lagoon surface shall be finished to a smoothness so the surface can readily be traveled upon by farm type equipment. One or more of the lagoon corners may be rounded to facilitate lagoon agitation and pumpout equipment. Final construction shall be considered satisfactory when:

- Excavation elevations are within ± 0.2 foot of design grade or modified grade,
- Fill elevations are not less than design height plus settlement, and
- Slopes are at design slopes or are flatter than designed. Slopes will be uniform throughout their length (Allowance for anticipated slope settlement may be considered when calculating side slopes for construction check).

Select backfill material shall be placed around the pipe and concrete chute structure. Preparation of a shaped bed with one-inch of moist, loose soil supporting about one-third of pipe circumference will help insure the pipe to soil contact. Minimum cover over the pipe shall be 1 foot.

4. **CONSTRUCTION MATERIALS**

Pipe conduit shall be PVC material meeting the appropriate ASTM specifications. It shall be free of defects and shall be assembled with watertight connections and be placed on a continuous positive grade.

Concrete used in construction of chutes, curbs, or gutters shall have a minimum of 6 bags of cement per cubic yard and a maximum of 6 gallons of water per bag of cement. Concrete shall be evenly distributed in the forms and spaded or mechanically vibrated to assure consolidation. Concrete shall be finished smooth for delivery of wastes to the lagoon.
A 6x6x10 wire mesh shall be placed in the center of the concrete in the chute section and cutoff walls.

5. **VEGETATIVE COVER**

A protective cover of vegetation shall be established on all exposed surfaces of the embankment, borrow, and waste disposal areas. Seedbed preparation, seeding, fertilization, and mulching shall comply with the specification for Critical Area Planting (342). A fence shall be installed to protect the vegetative area from livestock.

6. **MEASUREMENT**

Measurement of earthfill or excavation, as appropriate, will be the design yardage computed to the nearest cubic yard from the natural ground line to design neat lines.

Measurement of vegetative planting area will be all disturbed areas (embankment, borrow, waste) above and outside the maximum operating level of the lagoon computed to the nearest 0.1 acre.

Measurement of pipe conduit will be the field laying length installed. No separate accounting of appurtenances (band, tee, ell, etc.) will be made. The length of each size of pipe used will be identified.

7. **CONSTRUCTION DETAILS**

________________________________________________________________________
________________________________________________________________________
WORKSHEET FOR WASTE TREATMENT LAGOON

<table>
<thead>
<tr>
<th>County: ________________________________</th>
<th>Tract: ___________</th>
<th>Farm No.: __________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client: ________________________________</td>
<td>Date: ____________________</td>
<td></td>
</tr>
<tr>
<td>Address: ________________________________<strong><strong><strong><strong><strong><strong><strong><strong><strong>, MS</strong></strong></strong></strong></strong></strong></strong></strong></strong></td>
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<tr>
<td>Facility Location: Township __________, Range __________, Section __________, ________1/4</td>
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<tr>
<td>Lagoon Discharge (&gt;25 year, 24 hour event) will flow overland into stream_________________, thence to _____________________, thence to _____________________________________.</td>
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<tr>
<td>Designed By: ______________________</td>
<td>Checked By: ________________________________</td>
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<td>Approved By: ______________________________ Date: ______________________________</td>
<td></td>
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</tr>
</tbody>
</table>

Landowner’s certification that data provided and number of animals are true and accurate:

<table>
<thead>
<tr>
<th>Animal units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Animal type ____________________________</td>
</tr>
<tr>
<td>2. Number of animals planned ______________________</td>
</tr>
<tr>
<td>3. Animal average weight, lbs ____________________________</td>
</tr>
<tr>
<td>4. Animal units, AU = (2) x (3) 1000</td>
</tr>
<tr>
<td>= (<strong><strong><strong>) x (</strong></strong></strong>) 1000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manure volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Daily volume of manure, ft³/AU/day* = ________</td>
</tr>
<tr>
<td>6. Treatment period, days = ________</td>
</tr>
<tr>
<td>7. Confinement period = _____ hrs/24 hrs = _______%</td>
</tr>
<tr>
<td>= (<strong><strong><strong>) x (</strong></strong></strong>) x (<strong><strong><strong>) x (</strong></strong></strong>)</td>
</tr>
<tr>
<td>8. Total volume of manure, ft³ = (4) x (5) x (6) x (7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wastewater volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Daily wastewater volume gallons/day = _______________</td>
</tr>
<tr>
<td>10. Total wastewater volume for treatment period, ft³ = (9) x (6) 7.48 = (_____ ) x (_____ ) = __________ ft³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum Treatment Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Volatile solids, lbs/AU/day* = ________________</td>
</tr>
<tr>
<td>12. Total volatile solids, lbs/day = (4) x (11) = (_____ ) x (_____ ) = __________</td>
</tr>
<tr>
<td>13. Selected lagoon VS loading rate, lbs VS/1,000 ft³/day ** = __________</td>
</tr>
<tr>
<td>14. Minimum treatment volume, ft³ = (12) x 1000 x (7) = (_____ ) x 1000 x (_____ ) = __________ ft³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sludge volume requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Sludge volume requirement, ft³ = (15) x (16) x (4) x (7)</td>
</tr>
</tbody>
</table>
15. Sludge accumulation rate: Dairy - 266 ft³/au. yr.  
   Swine - 112 ft³/au. yr.  
   = (______) x (______) x (______) x (______)  
   = __________________

16. Sludge accumulation period, years = _______

**Feedlot Runoff Volume**

18. Precipitation during treatment period, in. = _______

19. Concrete feedlot/watershed area, ft² = ________________

20. Runoff volume = (18) x (19) x 64% = (______) x (______) x 0.64 = ___________ ft³

**Lagoon volume requirement**

21. Lagoon volume requirements, ft³  
   = Manure + waste water + MTV + sludge + runoff  
   = (8) + (10) + (14) + (17) + (20) = __________ + __________ + __________ + __________ + __________ = ___________ ft³

**Lagoon size**

22.  
   \[ V = \left(4 \times Z^2 \times D^3\right) + \left(Z \times BL \times D^2\right) + \left(Z \times BW \times d^2\right) + \left(BW \times BL \times D\right) \]  
   \[ D = \text{depth}^{***} \]  
   \[ BL = \text{bottom length} \]  
   \[ BW = \text{bottom width} \]  
   
   or  
   \[ V = D \left(\frac{AT + 4AM + AB}{6}\right) \]  
   \[ D = \text{depth}^{***} = \text{________}_x\text{________} \]  
   \[ AT = \text{area of top} = \text{________}_x\text{________} \]  
   \[ AM = \text{area of middle} = \text{________}_x\text{________} \]  
   \[ AB = \text{area of bottom} = \text{________}_x\text{________} \]  
   
   Volume**** = _________________ ft³

**Depth adjustment**

23. Depth adjustment  
   Depth, ft (from previous step) ................................................................. _______  
   Add depth of precipitation less evaporation on lagoon surface for the treatment period ................................................................. + _______  
   Add depth of 25-year, 24-hour storm ................................................................. + _______  
   Add for freeboard (1.0 foot minimum)................................................................. + _______  
   Final depth ............................................................................................................. _______

*Refer to AWMFH Table 4-5 Dairy, Table 4-11 Swine, and Table 4-14 Poultry  
**Refer to AWMFH Figure 10-22  
***Depth must be adjusted in Step 23.  
****Limited by job approval authority