

UNITED STATES DEPARTMENT OF AGRICULTURE
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

Federal, State, and Local Laws. All planned activities shall comply with all federal, state, and local laws and regulations. The Alabama Department of Environmental Management (ADEM) Rules require owners/operators of

animal feeding operations (AFO's) and associated waste management systems to fully implement and regularly maintain effective best management practices (BMP's) that meet or exceed NRCS technical standards and guidelines to prevent discharges and to ensure groundwater and surface water quality. AFO owners/operators who fail to implement BMP's or whose facilities discharge or have the significant potential to discharge to "waters of the state" can be required by ADEM or the Environmental Protection Agency (EPA) to implement effective corrective actions immediately. If preventive or effective actions are not fully implemented in a timely manner, civil penalties may be incurred by the owners/operators.

All construction activities must implement adequate stormwater management BMP's. In addition, to comply with the National Pollutant Discharge Elimination System (NPDES) Phase II Rule, all construction activities involving one acre or more of land disturbance shall have and follow a Construction Best Management Practices Plan (CBMPP) until construction is complete and all disturbed areas are stabilized.

ADEM AFO rules require that operators retain records documenting that (1) all designs and plans for any structures were prepared and certified by a professional engineer (PE) registered in the State of Alabama, (2) construction was supervised by a PE, and (3) once construction was completed, a PE certified that the completed facility was constructed in accordance with the approved plans and met or exceeded good engineering practices and NRCS technical standards and guidelines, and (4) any modifications or repairs made to the structures were supervised and certified by a PE.

Location. Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized, and where prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values. The lagoon shall not be located within a 100-year floodplain unless it is protected from inundation or damage that may occur during that flood event.

Waste treatment lagoons shall be located to meet the minimum buffer distance requirements from water(s), wells, property lines, and public or private facilities as defined in the ADEM Administrative Code, Chapter 335-6-7, as amended.

Hazard Classification. The area downstream of the embankment shall be evaluated to determine the impact of damage from a sudden breach of the proposed embankment on both structural and environmental features. This evaluation must consider all improvements and those improvements that may reasonably be expected to be made during the useful life of the structure. The results of this evaluation provide for the proper hazard approval classification of the embankment. Only hazard Class "a" embankments are to be designed under this standard. See National Engineering Manual (NEM) Part 520 for guidance in documenting hazard classification.

Soils and Foundation. The lagoon lining shall have a permeability of 1×10^{-7} cm/sec or less, or a maximum allowable operational specific discharge of no more than 0.0028 ft/day. (NOTE: These rates may be reduced one order of magnitude due to manure sealing). The lagoon shall be located in soils that shall not exceed these rates or shall be sealed by a low permeability liner. Where possible, avoid sites with gravelly soils and shallow soils over fractured or cavernous rock. A detailed soils investigation with special attention to the water table depth and seepage potential must be considered in each design. Soil investigations must evaluate soils to a depth no less than 2 feet below the final grade of any excavation. Subsurface investigation in soils underlain by the Demopolis or Mooreville Chalk formations of the Selma Chalk group in the Blackland Prairie major land resource area may terminate at a depth of 1 foot below the surface of the chalk.

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.

Foundations consisting of bedrock with joints, fractures, or solution channels shall be separated from the bottom of the floor slab or liner by a minimum of one foot of low permeability soil [type III or IV as described in the National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D] or by an alternative that will achieve equal protection.

Liners. Self-sealing lagoons are not an acceptable means of containing waste. The subgrade shall be sufficiently dense and be filter compatible to facilitate installation of the selected liner. All liners shall be protected from damage during filling, agitating, and pumping operations. The lagoon shall be sealed by one of the liners as described below:

1. Compacted earth liner. An earth liner designed in accordance with the AWMFH, Appendix 10D.

The soil to be used in construction of the liner shall be tested to determine the degree of compaction and moisture content required to achieve the maximum allowable operational specific discharge or less.

Compacted earth liners shall have a minimum thickness of 1 foot on lagoon side slopes and bottom measured perpendicular to the finished surface. The final liner thickness shall be determined using procedures in AWMFH, Appendix 10D. The liner material shall be placed in loose layers not over 9 inches thick and compacted to the required density. Moisture content before compaction shall be as prescribed by a soil mechanics report. During construction the liner shall be tested at sufficient locations to verify that the specified degree of compaction and moisture content have been achieved.

Compacted earth liners shall have side slopes of 3 horizontal to 1 vertical (3:1) or

flatter, except where compacted earth liners are part of (brought up with) an earthfill operation. When the plasticity index (PI) of the compacted earth liner exceeds 20, the liner shall be covered with not less than 1 foot of compacted on-site material measured perpendicular to the finished surface.

2. **Flexible membrane.** A flexible membrane liner designed and constructed in accordance with the Alabama NRCS conservation practice standard Pond Sealing and Lining (Flexible Membrane), Code 521A.
3. **Bentonite.** A bentonite liner designed and constructed in accordance with AWMFH, Appendix 10D and the Alabama NRCS conservation practice standard Pond Sealing and Lining (Bentonite), Code 521C. The bentonite liner shall be covered with not less than 1 foot of compacted on-site material measured perpendicular to the finished surface to protect from drying cracks and weathering.
4. **Soil Dispersant.** A soil dispersant liner designed and constructed in accordance with AWMFH, Appendix 10D and the Alabama NRCS conservation practice standard Pond Sealing and Lining (Soil Dispersant), Code 521B.
5. **Concrete.** A watertight concrete liner designed, constructed, and maintained in accordance with the criteria for fabricated structures in Alabama NRCS conservation practice standard Waste Storage Facility, Code 313, and the following criteria:
 - a. For side slopes and bottoms that will not have any vehicular traffic, use a minimum 4-inch concrete slab placed over a minimum 6-inch layer of well-compacted, low plasticity foundation material. A flexible waterstop will be required in all joints.
 - b. For concrete lined areas such as approaches, ramps, and bottoms that will have vehicular traffic of any kind, use a minimum 4-inch concrete slab placed over a minimum 6-inch layer of well-compacted granular material. Concrete joints and reinforcement shall be as required by design analysis.

- c. Concrete lined side slopes shall be 2 horizontal to 1 vertical (2:1) or flatter, except for concrete push-off ramps. Concrete push-off ramp slopes shall be 1 horizontal to 1 vertical (1:1) or flatter on cut slopes and 2 horizontal to 1 vertical (2:1) or flatter on embankment slopes.

Natural Clay Base. In situ soils classified in permeability groups III or IV as defined in AWMFH, Appendix 10D are acceptable as a low permeability lining provided they have a minimum thickness of 2 feet below the deepest excavation limits and are at dry densities equivalent to at least 90 percent Standard Proctor (ASTM D 698). The required minimum thickness of the natural clay base shall be determined using procedures in AWMFH, Appendix 10D. Special precautions must be taken if the soils contain high amounts of calcium. Subsurface investigations must demonstrate that suitable natural soil material exists for the minimum depth required below the design bottom elevation of the lagoon and that no highly unfavorable geologic conditions occur at the site.

Excavated side slopes in natural materials shall be 2 horizontal to 1 vertical (2:1) or flatter.

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

Required Volume. The required volume for lagoons shall include a volume for the following:

- Minimum treatment volume (MTV) for anaerobic lagoons only
- Manure, wastewater, and other wastes accumulated during the treatment period
- Normal precipitation (on the maximum collection area inside the top of the lagoon) less evaporation (on the average lagoon surface area of the required treatment period volume) and any runoff from drainage areas that enter the lagoon during the treatment period

- Volume of accumulated sludge (2-year minimum) for the period between sludge removal events
- The 25-year, 24-hour storm volume (the volume resulting from the rainfall from the 25-year, 24-hour storm on the maximum collection area inside the top of the lagoon plus the runoff from any contributing drainage area from the 25-year, 24-hour storm). In accordance with ADEM's and EPA's concentrated animal feeding operation (CAFO) rules, a new lagoon for a large CAFO for swine, veal, and poultry must contain the volume from the 100-year, 24-hour storm. Large CAFO's are defined as those confining the following number of animals or more:
 - 1,000 veal calves
 - 2,500 swine weighing \geq 55 pounds
 - 10,000 swine each weighing < 55 pounds
 - 30,000 laying hens or broilers

For determining the portion of the required volume that involves precipitation and evaporation, the treatment period during the year that will produce the largest volume shall be used, based on average monthly precipitation and evaporation tables.

Multiple Cells. When multiple cells are used, the volume of the primary cell shall be the sum of the MTV plus a 2-year sludge accumulation volume, minimum. The remaining volumes shall be in the following cell(s), with normal precipitation, storm volumes, and freeboard being designed and maintained in the final cell. All cell(s) prior to the final cell shall have 1 foot minimum freeboard with the overflow structure passing the 25-year, 24-hour storm, but do not require an auxiliary spillway.

Waste Loading. Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Design loading shall be based on the maximum average weight of animals using the lagoon and on other waste introduced. Reliable local information or laboratory test data should be used if available. If local data is not available, Chapter 4 of the AWMFH should be used for estimating waste loading.

Treatment Design. A lagoon's treatment function shall be designed on the basis of the 5-day biochemical oxygen demand (BOD₅) or

volatile solids (VS) loadings as appropriate. Design volumes shall be determined by methods in Chapter 10 of the AWMFH, as a minimum.

Maximum Operating Level. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm volume (the 100-year, 24-hour storm volume, if applicable).

Freeboard. Freeboard is the vertical distance between the settled top of dike of a lagoon and the designed liquid level in the lagoon with the auxiliary spillway or overflow structure operating at the design discharge. This distance shall be a minimum of 1 foot.

Embankment. The height of the embankment shall be increased during construction by the amount needed to ensure that the designed height will be maintained after settlement. This increase shall not be less than 5 percent. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical (5:1), and neither slope shall be steeper than 2 horizontal to 1 vertical (2:1) unless special provisions are made to provide stability. The top of the dike shall slope slightly toward the outside dike slope in order to direct as much rainfall as possible from the lagoon.

The minimum top width shall be as shown in Table 1. If the embankment top is to be used as a road, the minimum top width shall be 16 feet for one-way traffic and 26 feet for two-way traffic, and provisions shall be made for protecting the auxiliary spillway from damage. Guard rails or other safety measures shall be used where necessary.

Total height of embankment ft	Top width, ft
<15	8
15 to <20	10
20 to <25	12
25 to <30	14
30 to 35	15

Compaction of the embankment fill material shall be in accordance with the specified design requirements for compaction and moisture content. As a minimum compaction shall be equivalent to, or better than, the following:

1. Layers of loose fill shall not exceed 9 inches in thickness before compaction. 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 two complete passes of the loaded equipment traveling in a direction parallel to the main axis of the fill.
2. If a minimum required density is specified, each layer of fill shall be compacted as necessary to obtain the density. Special equipment shall be used, if needed, to obtain the required moisture content and degree of compaction.

Excavations. Excavated side slopes shall be stable and not less than 2 horizontal to 1 vertical (2:1) unless provisions are made to provide stability. The bottom of aerobic lagoons shall be approximately level.

Runoff Exclusion. A low embankment shall be constructed if needed to exclude uncontaminated surface runoff from the pond. The embankment shall meet the criteria contained in the section "Embankments" of this standard.

Embankment Lagoon and Overflow

Protection. Embankment lagoons (those having a maximum operating level against the embankment of 3 feet or more above natural ground) shall be provided with an auxiliary spillway, overflow structure, or combination to protect the embankment from overtopping when the lagoon is at the maximum operating level and a 25-year, 24-hour storm volume (the 100-year, 24-hour storm volume, if applicable) is exceeded. The crest of the auxiliary spillway or overflow structure shall be located at or above an elevation that will contain the 25-year, 24-hour storm volume (the 100-year, 24-hour storm volume, if applicable). This elevation shall be a minimum of 1 foot above the maximum operating level. The auxiliary spillway, overflow structure, or combination shall be designed to pass the 25-year, 24-hour storm volume while maintaining the required minimum freeboard of 1 foot.

The auxiliary spillway shall be placed in undisturbed soil when possible. When it must be placed in fill material, precautions shall be taken to insure the integrity of the structure. When locating the auxiliary spillway, areas near the lagoon corners and the side containing the inlet shall be avoided, if possible.

Excavated Lagoons. Excavated lagoons (those having a maximum operating level against the embankment of less than 3 feet above natural ground) do not require an auxiliary spillway, overflow structure, or freeboard unless they are in a series of multiple cells (see the section "Multiple Cells" in this standard) or have an outside drainage area (include overflow protection as for an embankment lagoon). The vertical distance from the maximum operating level to the settled top of the embankment shall provide storage for the 25-year, 24-hour storm volume (the 100-year, 24-hour storm volume, if applicable) or be a minimum of 1 foot, whichever is greater.

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 designed to carry the peak rate of waste flow to the lagoon without leakage or other soil contact by the wastes, unless a portion of the inlet incorporates a wastewater treatment strip as part of the overall design. 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.

Inlets may be push-off ramps, paved slopes, or pipe inlets. If freezing is not a problem, an open inlet, such as a concrete channel, may be used. Paved slopes shall be no flatter than 4 horizontal to 1 vertical (4:1) and shall not be used when appreciable bedding materials are used.

Pipe inlets may be steel, concrete, aluminum, or plastic meeting the requirements of Alabama NRCS conservation practice standard Pond, Code 378. However, if corrugated steel is used, it shall be adequately protected with an appropriate coating.

Pipe inlets shall have a minimum diameter of 6 inches and shall be designed to carry the required flow without plugging. Pipes shall be installed on a slope of 1 percent or greater. Wye or tee fittings shall be placed at a maximum

spacing of 150 feet to facilitate cleanout of the pipe in case of blockage. The inlet pipe should extend a sufficient distance from the shoreline to ensure good distribution. Pipes shall be installed far enough below the ground surface to avoid freezing or be provided with other protective measures.

Pumped inlets shall be sized to meet the requirements of the pumping equipment. The slope of the lagoon and the liner at the pipe outlet shall be protected from erosion by paving, extending the pipe outlet to a point where the discharge will not fall directly on the slope resulting in damage to the slope or liner, or using a flexible down pipe at the pipe outlet during filling. Pipes installed above ground shall be supported on pilings of pressure treated wood, steel, concrete, or masonry and anchored to prevent dislodging or flotation. Pilings shall be installed so as to maintain liner integrity.

Outlet. No outlet shall automatically discharge wastewater from a level below the surface elevation of the required volume of the lagoon. Outlets from the waste treatment lagoon shall be designed to resist corrosion and plugging, and manually operated outlets shall be of a permanent type.

Pipe auxiliary spillways shall be 6-inch minimum diameter and equipped with trash racks, antivortex devices, and antiseep collars and may be steel, concrete, aluminum, or plastic as required in Alabama NRCS conservation practice standard Pond, Code 378.

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. Ramps used to withdraw supernatant shall have a slope of 4 horizontal to 1 vertical (4:1) or flatter.

Where agitators are used in lagoons with liners, the tip of the propeller shall be a minimum of 3 feet from the liner surface or the liner shall be protected by a concrete pad. The agitator shall be positioned so that agitated flow will not cause scouring of an adjacent slope.

Sludge Removal. Provision shall be made for removal of accumulated sludge to preserve the

treatment capacity of the lagoon. The anticipated method for accomplishing this must be considered in determining the size and shape of the lagoon and type of liner.

Waste Application. All waste removed from the lagoon shall be utilized in accordance with Alabama NRCS conservation practice standard Nutrient Management, Code 590.

Erosion Protection. To control erosion, embankments and disturbed areas surrounding the lagoon shall be vegetated according to Alabama NRCS conservation practice standard Critical Area Planting, Code 342.

Safety. Designs shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced and warning signs posted to prevent anyone from using it for anything other than its intended purpose. A warning sign (90 in² minimum) shall be placed on each straight section of fencing, not to exceed a spacing of 300 feet, to alert the public to the hazards of the lagoon. Fencing shall meet the requirements of Alabama NRCS conservation practice standard Fence, Code 382, with safety as the objective.

Staff Gage. A staff gage shall be placed in the lagoon with a marker for the maximum operating level allowed and the level of the auxiliary spillway, if applicable. The staff gage will have incremental marks which will coincide with a stage-storage curve for the operator's use in monitoring waste volumes in the lagoon. The maximum drawdown level will also be marked on the staff gage. The markings and the stage-storage curve shall be referenced and described in the operation and maintenance (O&M) plan.

Additional Criteria for Anaerobic Lagoon

Loading Rate. Anaerobic waste treatment lagoons shall be designed to have a MTV based on volatile solid (VS) loading per unit of volume. The maximum loading rate shall be as indicated in Figure 10-22 of the AWMFH or according to state regulatory requirements, whichever is more stringent. If a high degree of odor control is necessary, loading rates shall be decreased.

Operating Levels. The maximum drawdown level shall be the lagoon level that provides volume for the required MTV plus the volume of accumulated sludge between sludge removal events, except when the lagoon is in drawdown

to permit sludge removal or the addition of dilution water. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level.

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 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 in Figure 10-25 of the AWMFH or according to state regulatory requirements, whichever is more stringent.

Operating Levels. The maximum drawdown level shall be the lagoon level that provides a volume for the manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events, except when the lagoon is in drawdown to permit sludge removal or the addition of dilution water. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level.

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 lagoons' treatment function shall be designed on the basis of daily BOD₅ loading and the 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 not exceed the site and aeration equipment limitations. 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.

Lagoons Constructed in High Water Table Soils

Lagoons constructed in high water table soils shall be based on a detailed risk assessment. The risk assessment shall include an analysis of the potential for ground water pollution considering the hydrogeology, ground water transmissivity, soil permeability, etc. Decisions to install lagoons in high water table soils without liners must provide reasonable assurances that it will not cause surface or ground water pollution.

If during the risk assessment, it is determined that the site is a potential hazard to ground water pollution, it shall be designed with a liner to prevent contamination of ground water. Methods to maintain the liner integrity shall be included in the design.

The 25-year, 24-hour storage volume (the 100-year, 24-hour storm volume, if applicable) for lagoons constructed in high water table soils shall be in the volume above the natural high water table elevation.

CONSIDERATIONS

General Considerations

Waste treatment lagoons are of three general types: (1) anaerobic, (2) naturally aerobic, and (3) mechanically aerated. 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 are generally odor free, but they require energy for aeration.

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

To reduce sludge buildup, route wastes through a solids separator to remove solids from the waste of animals that are fed high roughage rations, such as dairy cattle. This may be a mechanical separator or a concrete or earthen structure that can be emptied periodically. Settling facilities should have adequate capacity to store settled solids for a time period based on climate, equipment, clean out frequency, and

method of disposal. Solid separators, debris basins, etc. shall be designed to prevent seepage to the groundwater.

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

In order to reduce the impact of objectionable odors on the public and the potential for pollution of the water resources, the lagoon location should meet the minimum distance requirements from public and private facilities as shown in Table 2. It is recommended that these distances be increased wherever possible in order to minimize any negative impacts of the lagoon. In no case shall the lagoon siting distances be less than the minimum distance requirements as required by the ADEM Administrative Code Chapter 335-6-7, as amended. ADEM's regulatory minimum distances are summarized in the ADEM/NRCS Buffer Distance Summary for Animal Feeding Operations.

Table 2. Minimum Distance Requirements for Waste Treatment Lagoons	
Public or Private Use Facilities	Minimum Distance from Lagoon
Any public use area or DCSHP ^{1/}	700 feet
Well, down gradient from lagoon	300 feet
Well, up gradient from lagoon	150 feet
Natural Water Courses	200 feet
Milking Parlor	100 feet
Drainage Ditches	100 feet
Area specified by state or local ordinance.	Greater of state or local distance or distance shown above.

^{1/} DCSHP: Non-owner existing occupied Dwelling, Church, School, Hospital, or Park

Vegetative screens or other methods should be used to shield the lagoon from public view and to improve visual conditions.

Non-polluted runoff should be excluded from the lagoon to the fullest extent possible.

Lagoons will have an affect on the water budget. The affect will be dependent upon the size of the lagoon. The lagoon will cause an increase in evaporation and a decrease in downstream runoff where drainage is routed to the facility.

The lagoon should have an overall positive impact on water quality by treating animal waste and polluted runoff until it can be safely applied to the land. There can be a positive effect on water related wildlife habitat by providing open water bodies. Water quality can be adversely impacted during initial construction due to erosion of the site but will be minimal using proper construction pollution prevention measures.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. Where there is potential for significant impact, the plan shall include site specific emergency action plan provisions for minimizing the impact.

Due consideration should be given to economics, the overall waste management system, 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 3 may be significantly affected.

Table 3. 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. Farmsteads, or other areas of habitation
4. Off-farm property
5. Riparian areas
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places

The following should be considered either individually 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 3 may be affected:

- An auxiliary spillway
- Additional freeboard
- Design 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
- Liquid 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 3 may be 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 waste treatment lagoon seepage when any of the

potential impact categories listed in Table 4 may be affected.

Table 4. 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)

Should any of the potential impact categories listed in Table 4 be affected, consideration should be given to the following:

- A liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that final specific discharge is 0.0028 ft/day or less
- A flexible membrane liner over a clay liner
- A geosynthetic clay liner (GCL) flexible membrane liner
- A concrete liner designed in accordance with criteria for watertight fabricated structures in Alabama NRCS conservation practice standard Waste Storage Facility, Code 313

Consideration 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 digesters, covers, and composting facilities.
- Use liquid/solid separation prior to discharge to lagoon to reduce VS loading and use composting of solids to further reduce gaseous emissions and odors.
- Design lagoons to be naturally aerobic or to allow mechanical aeration.
- Adjust pH below 7. This may reduce ammonia emissions from the lagoon but may increase odor when waste is surface applied.

PLANS AND SPECIFICATIONS

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.

Engineering plans, specifications, and reports shall include the following as a minimum:

- Type and number of animals the lagoon is designed to serve
- Plan view of system layout
- Soil and foundation findings, interpretations, and reports
- Typical cross sections of lagoon
- Drainage and grading plan
- CBMPP if one is needed
- Structural details of all components
- Quantities
- References to components supplied by others (pumps, etc.)
- Special safety requirements
- Vegetative requirements
- Construction specifications
- O&M plan.

OPERATION AND MAINTENANCE

An O&M plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The waste treatment lagoon shall be inspected periodically to ensure that all components are operating as planned.

The O&M plan shall contain the operational requirements for supernatant drawdown and sludge removal. It shall describe all operating levels as indicated on the staff gage and operation requirements of structural components, etc. The O&M plan shall include the requirement that waste be removed and utilized at locations, times, rates, and volumes in accordance with the overall waste management system plan. Records shall be kept of all waste applications according to Alabama NRCS conservation practice standard Nutrient Management, Code 590.

The lagoon shall be operated so that the liquid level is at the maximum drawdown level at the beginning of the most critical storage period

(usually late fall), and to maintain the storage capacity for the 25-year, 24-hour storm (the 100-year, 24-hour storm volume, if applicable). The O&M plan shall include the requirement that following storms, waste shall be removed at the earliest environmentally safe opportunity to ensure that sufficient volume is available to contain the 25-year, 24-hour storm volume (the 100-year, 24-hour storm volume, if applicable). The plan shall also include an explanation of the use of the staff gage and stage-storage curve to indicate the operating levels and volumes in the lagoon.

Prior to initial filling, the inside slopes of the dikes above the initial fill level shall be vegetated, mulched, or mechanically protected to prevent erosion. The embankment and other vegetated areas shall be mowed and fertilized to maintain a protective vegetative cover. Trees can cause leaks and safety hazards. Trees and shrubs should not be allowed to grow within a potential distance of their root zones to the embankment.

To reduce the risk of offensive odors during the initial operation and after dewatering for sludge removal, the lagoon shall be filled with fresh water to 60% of the MTV or 50% of the depth at the maximum operating level, whichever is greater.

REFERENCES

- ADEM Administrative Code, Chapter 335-6-7, as amended
- ADEM/NRCS Buffer Distance Summary for Animal Feeding Operations
- Alabama NRCS Conservation Practice Standards
 - Critical Area Planting - Code 342
 - Fence - Code 382
 - Manure Transfer - Code 634
 - Nutrient Management - Code 590
 - Pond - Code 378
 - Pond Sealing and Lining
 - Flexible Membrane - Code 521A
 - Soil Dispersant - Code 521B
 - Bentonite Sealant - Code 521C
 - Waste Storage Facility - Code 313
- ASTM Specification D698
- EPA CAFO Final Rule, 40 CFR
 - Parts 9, 122, 123, and 412
- National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook (AWMFH)
- NEM, Part 520, Streams and Channels

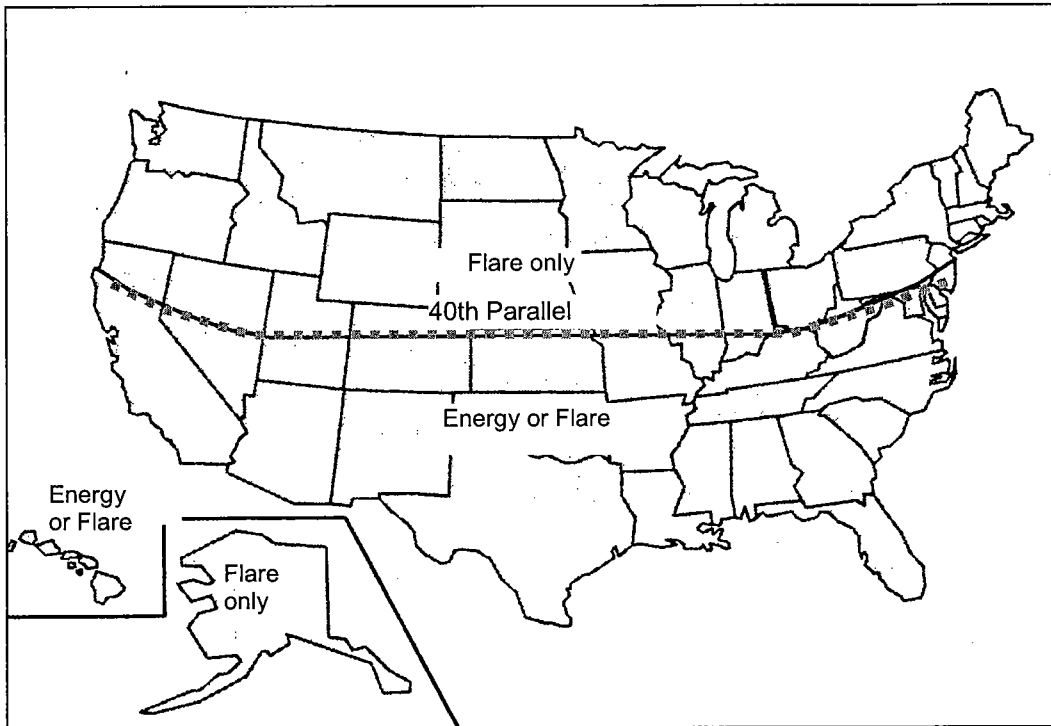


Figure 1. Ambient temperature digester. Locations suitable for energy production generally fall below the 40th parallel.

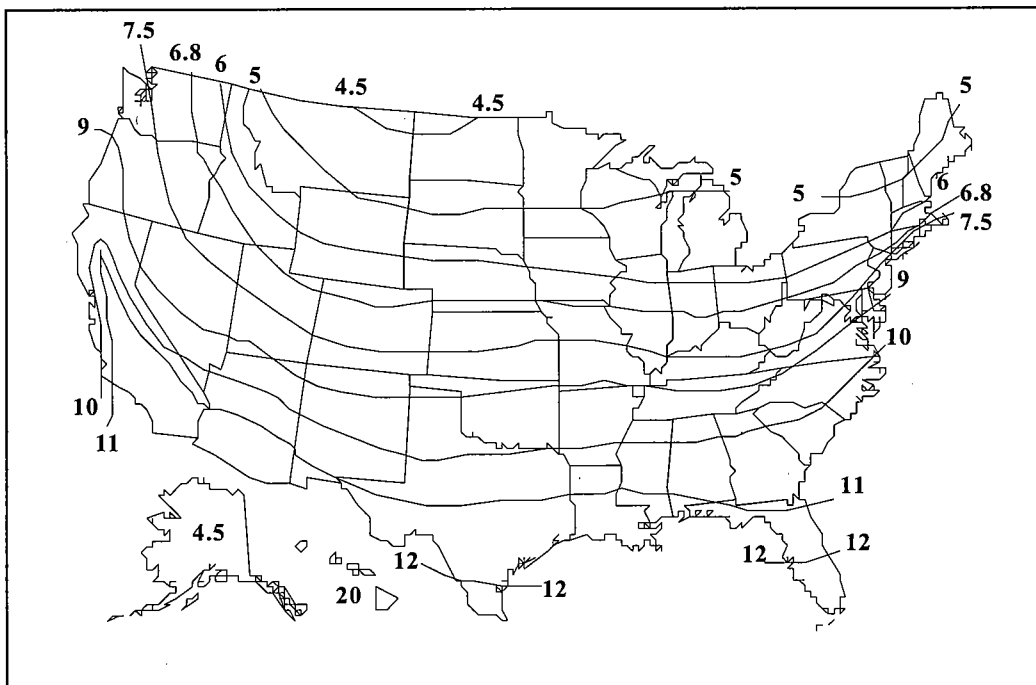


Figure 2. Covered anaerobic digester maximum loading rate (lb VS/1,000 ft³/day)

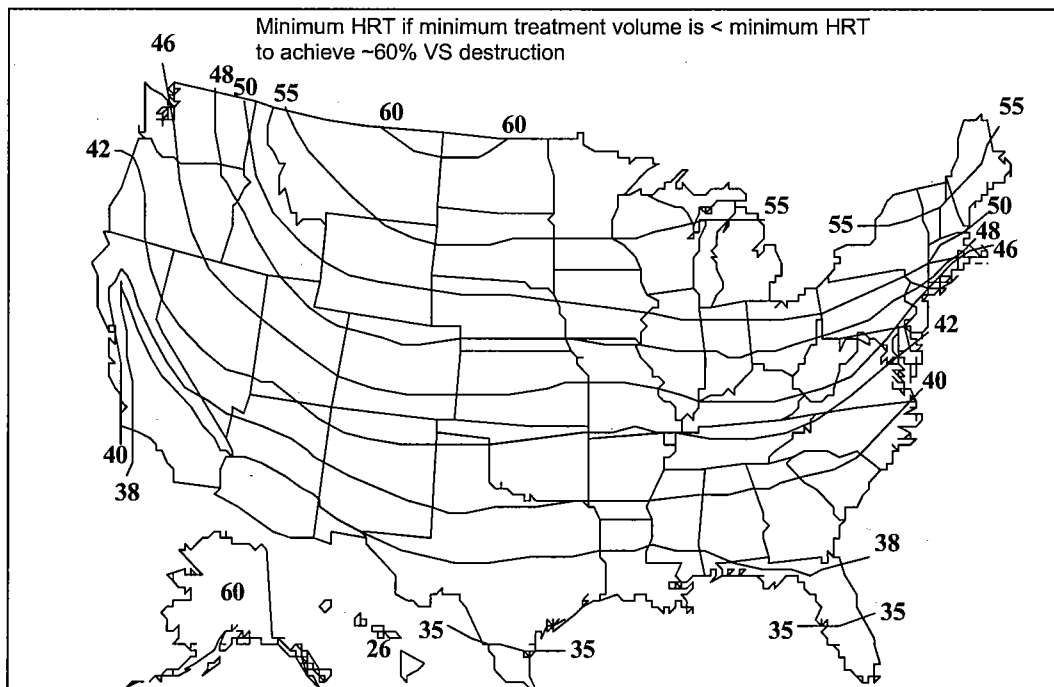


Figure 3. Covered anaerobic digester minimum hydraulic retention times (MINHRT) in days