Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WASTE TREATMENT LAGOON

CODE 359

(no)

DEFINITION

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

PURPOSE

This practice is applied for one or more of the following purposes:

- Reduce nitrogen, phosphorus, and biological oxygen demand of the effluent
- Reduce manure odors

CONDITIONS WHERE PRACTICE APPLIES

Use where storage and treatment is needed for organic wastes generated by agricultural production or processing and where soils, geology, and topography are suitable for construction of the facility. For reception pits, use NRCS Conservation Practice Standard (CPS) Waste Transfer (Code 634).

For liquid waste storage facilities implemented with an embankment, this practice applies only to low hazard structures as defined in NRCS 210-National Engineering Manual (NEM), Part 520, Subpart C, Section 520.23, “Classification.”

To lagoons utilizing embankments with an effective height of 25 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads. (NRCS Classification is Class (a))

This practice does not apply to the storage or treatment of human waste or animal mortality.

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations

Plan, design, and construct the waste treatment lagoon to meet all Federal, State, and local laws and regulations.

Location

Locate and design the waste treatment lagoon such that it is outside the 100-year floodplain unless site restrictions require locating it within the floodplain. 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 FOR SWINE SHALL NOT BE LOCATED IN THE 100- YEAR FLOODPLAIN.**

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 near the source of waste and as far from neighboring dwellings as practicable.

Runoff from outside drainage areas shall not enter the lagoon.

Minimum distances from wells and other water sources must comply with state and local ordinances. It is the responsibility of the designer to ensure that current state and local distance requirements are met. The following tables show minimum distances.

Additionally, follow the policy found in NRCS 190-General Manual (GM), Part 410, Subpart B, Section 410.25, “Flood Plain Management,” that may require providing additional protection for storage structures located within the floodplain.

Table 1. Minimum Distance for all Animals Except Swine Facilities Sited Under General Statute 106 - 801 through 805

Public or Private Use Facilities	**Minimum Distance from Facilities**	
	Operation existing prior to 04/15/87 (no enlargement) (no increase in SSLW)[1]	**New operation or existing operation that is enlarging SSLW[2]**
Any public use area, church, picnic area, playground, etc.	300 ft.	750 ft.
Residence or place of habitation other than owner or his tenant	300 ft.	750 ft.
“Blue line” or perennial water	100 ft. (New or Expanding Operations)	
Wells	100 ft. minimum - General Statutes 87-87 & 87-88. 15A02C.0107 (a) (1) (c)	
Area specified by state or local ordinance	Greater of state/local or NRCS distance shown above	

[1] SSLW - Steady State Live Weight = Average weight per unit x number of units @ capacity.

Any exception to the above distances must be approved by the ASTC (FO) with concurrence from the State Conservation Engineer.

[2] The 750 ft. minimum distance must exist the day of the site investigation. Site evaluations are valid for 12 months.

Table 2. Minimum Distance for Swine Operations as Dictated by GS 106 - 801 through 805 as amended by HB-515

(Applies to swine operations sited on or after 8/27/97)	
Swine House or Lagoon	• >= 1,500 ft. from any occupied residence • 2,500 ft. from any school, hospital, church, outdoor recreational facility, national park, historic property, or child care center • 500 ft. from any property boundary • 500 ft. from any well supplying water to a public water system
Land Application	• 75 ft. from any residential property boundary (any property with a residence on it) • 75 ft. from any perennial stream or river other than an irrigation ditch

Note: Waste Treatment Lagoons and Waste Storage Ponds are the same in respect to SB-1080.

Odor Control
As a minimum, the following will be used to reduce odor on all lagoons:

- New or emptied lagoons shall be pre-charged with a volume of water equal to one-half of the treatment volume before wastes are introduced so that solids discharged into the lagoon are submerged.
- Pipes discharging wastes into the lagoon shall be extended beneath the surface of the lagoon to avoid releasing gases from agitated wastes.
- Intake pipes for effluent removal shall be placed in the aerobic layer of liquid approximately 18 inches below the surface. A floating intake may be used.

When practicable, a dense stand of trees and shrubs strategically placed around lagoons, production facilities, and fields can reduce or redirect winds helping to contain or disperse odors.

Hazard Classification
The area downstream of the embankment must be evaluated carefully to determine the impact from a sudden breach of the proposed embankment on both structural and environmental features. This evaluation must consider all existing improvements and those improvements that may reasonably be expected to be made during the useful life of the lagoon. The results of this evaluation provides for the proper hazard classification of the embankment. Only hazard class (a) embankments with a maximum effective height of 25 feet are to be designed under this standard. See Engineering Note keeping, Pond (Code N378) or National Engineering Manual (NEM) for guidance concerning documentation of hazard class determination.

Site Investigation
A detailed site investigation shall be made for each lagoon prior to design. This investigation should include, but not be limited to, evaluations of distance from residences and other private or public use facility, proximity to the 100-year floodplain, perennial streams as shown on the USGS Quad Sheet, zoning jurisdiction of municipalities, utilities in the construction area, wetlands, available land for disposal, soils, and other environmental factors. Form NC-CPA-17 may be used. When requested by the technical specialist, the owner shall furnish the distance from nearest residences or other private or public use facilities. At the discretion of the technical specialist, a survey by a registered land surveyor may be required to establish the distances.

If wetlands may be involved, contact the Corps of Engineers and/or NRCS for a wetland determination/delineation. If wetlands are involved, a 401 water quality certification and a 404 permit may be needed.

During the site investigation or construction phase, it must be verified that no subsurface tile lines are present. On sites that are located on cropland or land that has been cropped in the past and is land with soil types that respond to subsurface drainage, an observation trench along the entire length of the embankment shall be constructed to a minimum depth of 5 feet.

The observation trench may be excavated during the soils investigation phase or during construction; in which case, it may be incorporated into the cutoff trench. The trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations, and the side slopes shall be 1:1 or flatter. If any tile lines are present in the area of the embankment, they must be removed for a minimum distance of 15 feet beyond the embankment toe. If a tile line exists above the embankment it shall be rerouted around the lagoon.

Written Notice of Swine Farms
Any person who intends to construct a swine farm whose animal waste management system is subject to a permit shall, after completing a site evaluation and before the farm is modified, notify all adjoining property owners; all property owners who own property located across a public road, street, or highway

from the swine farm; the county or counties in which the farm is located; and the local health department or departments having jurisdiction over the farm site of that person's intent to construct the swine farm.

This notice shall be by certified mail sent to the address on record at the property tax office in the county in which the land is located. Notice to a local health department shall be sent to the local health director. The written notice shall include all of the following:

1. *The name and address of the person intending to construct a swine farm.*
2. *The address of the local Soil and Water Conservation District Office.*
3. *The name and address of the technical specialist preparing the waste management plan.*
4. *The type of swine farm and the design capacity of the animal waste management system.*
5. *Information informing the adjoining property owners and the property owners who own property located across a pubic road, street, or highway from the swine farm that they may submit written comments to the Division of Water Quality, Department of Environment and Natural Resources*

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.

Locate the lagoon on soils of slow to moderate permeability or on soils that can seal through sedimentation and biological action. Avoid gravelly soils and shallow soils over fractured or cavernous rock.

A detailed soils investigation with special attention to the water table and seepage potential must be a part of each design. The soils investigation must extend at least 2 feet below the planned bottom. In the vicinity of the embankment but not under it, the soils investigation shall be to a depth equal to the height of the embankment or until rock is encountered. When poor foundation conditions are anticipated, the investigation shall extend to a depth determined by the designer. A minimum of 5 test pits or 1 per 10,000 ft^2 of lagoon bottom is required.

When an embankment is involved, samples of the proposed fill material should be obtained and tested. Tests required are at the discretion of the designer. The test results shall be used to determine the design requirements for the embankment.

Since soils are not always consistent, small areas of unsatisfactory material that were not evident during the investigation may be found during construction. They should be over excavated and lined with clay or other suitable sealant material **as specified by the designer**. Other sealant or lining techniques should be planned according to industry- accepted design, installation and operational procedures appropriate for the selected technique.

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, if feasible, to meet this requirement.

Liners
If adequate rapid self-sealing is not probable, special considerations such as mechanical treatment, lining, or other techniques must be considered and addressed in the design. A liner, or equivalent sealant, is required in SP, SW, GP, and GW, or problem soils as classified according to the Unified Soil Classification System. A liner is also required for most SM soils. A determination as to whether a liner is needed for other soils will be made during the on-site soils investigation prior to the design.

If a liner is required and a clay liner is the sealant of choice, it will be designed and installed in accordance with AWMFH Appendix 10D guidelines. Where a liner is required, a qualified construction inspector, designated by the designer, must be on site during construction as necessary to verify proper liner construction or the liner must be tested to verify a maximum hydraulic conductivity of 1.25 x 10-6 cm/sec (0.003 ft/day).

Treatments or liners shall meet or exceed the requirements of Pond Sealing or Lining, Compacted Soil Treatment (Code 520).

Flexible Membranes
Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in Pond Sealing or Lining-Geomembrane or Synthetic Clay Liner (Code 521).

Treatment Period
The treatment period is the detention time between drawdown events or planned pumping interval incorporated into the waste utilization plan. 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. A minimum of at least 6 months temporary storage is recommended except when special management practices or techniques permit otherwise.

Storage period
The storage period is the maximum length of time anticipated between emptying events. Base the minimum storage period on the timing required for environmentally safe waste utilization considering the nutrient management plan. Base daily waste loading on the maximum daily loading anticipated. Include all waste sources to be treated by the lagoon. Use reliable local information or laboratory test data if available. If local information is not available, NRCS 210-National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH), Chapter 4, “Agricultural Waste Characteristics” may be used for estimating waste loading.

The values for waste production and the characteristics of fresh livestock manure given in Table 1 are from the North Carolina Cooperative Extension Service and should be used except for specific situations that deviate from normal. It should be noted that the amount of nutrients available for crops is different from the amount produced. See Waste Utilization (Code 633) and Nutrient Management (Code 590) for plant available nutrients and nutrient uptake values by various crops. Site specific data, when available, may be used in lieu of the information given in the table.

Domestic and industrial waste from washdown facilities, showers, toilets, sinks, etc. shall not be discharged into the animal waste management system.

Table 3. LIVESTOCK FRESH MANURE CHARACTERISTICS

	Average Animal Weight	Manure Production (Feces & Urine)		Nitrogen		Phosphorus P2O5	Potassium K2O
				Total N	Ammonia NH3N		
	(lbs)	(gal/day)	(tons/yr)	(lbs/ton)			
Dairy	1400	14.6	21.9	10.5	1.8	5.0	8.2
Beef	800	5.53	7.9	11.9	3.0	7.3	8.8
Veal	200	1.49	2.0	8.6	4.0	4.9	11.0
Swine	135	1.37	1.9	12.4	6.8	9.6	8.3
Sheep	60	0.28	0.4	20.8	6.2	9.9	19.4
Goat	140	0.69	1.1	21.8	6.5	12.1	17.7
Horse	1000	5.95	9.2	12.0	2.4	6.5	12.0
Rabbit	10	0.08	0.06	23.0	6.9	20.6	10.8

	Average Animal Weight	Manure Production (Feces & Urine)		Nitrogen		Phosphorus P2O5	Potassium K2O
				Total N	Ammonia NH3N		
	(lbs)	(gal/day)	(tons/yr)	(lbs/ton)			
Layer	4	0.03	0.05	26.2	6.6	21.1	11.4
Broiler	2	0.25	0.03	26.0	6.5	16.3	11.2
Turkey	15	0.08	0.12	26.7	3.4	22.5	12.3
Duck	3	0.04	0.05	27.8	5.3	22.5	15.6

Table 4. FRESH WATER

The following amount of excess water is to be added to the temporary storage		
Type of Operation	**Live Weight (lbs)**	**Excess Water (gal/day per unit)**
Nursery	30	0.2 / head
Finishing	135	0.9 / head
Farrow-Weanling	433	2.9 / sow
Farrow-Feeder	522	3.5 / sow
Farrow-Finish	1417	9.5 / sow
Boar-Stud	400	2.7 / animal
Gilt	150	1.0 / animal
Dairy	1400	6.0 / animal
Layers	4	0.013 / bird

Design volume
Size the facility to contain the following as appropriate:

Operational volume

- Manure, wastewater, bedding, and other wastes accumulated during the storage period.
- Minimum treatment volume (MTV) for anaerobic lagoons only.
- Normal precipitation less evaporation during the storage period.
- Normal runoff from the facility's drainage area during the storage period.
- Planned maximum residual solids. Provide a minimum of 6 inches for tanks unless there is a sump or other device allows complete emptying.
- Additional storage when required to meet management goals or regulatory requirements.

Emergency volume

- 25-year, 24-hour precipitation on the surface area within the top edges of the confining structure
- 25-year, 24-hour runoff from the facility's drainage area

Freeboard volume
Minimum of 12 inches

Exclude nonpolluted runoff from the structure to the fullest extent practical except where including the runoff is advantageous to the operation of the agricultural waste management system.

Inlet
Design inlet to resist corrosion, plugging, freeze damage, and ultraviolet deterioration. Incorporate erosion protection as necessary.

If freezing is not a problem, an open inlet, such as a concrete channel, may be used. If freezing is a problem, the inlet shall consist of a pipe having a minimum diameter of 6 inches and a minimum slope of 1

percent, except that a minimum diameter of 4 inches may be used for milking center waste. Inlets shall be provided with a water- sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

The inlet pipe shall terminate a sufficient distance from the shoreline to insure good distribution and prevent erosion of the lagoon side slope. It should be far enough below the surface to avoid freezing or be provided with other protective measures. It shall discharge the waste below the surface. Access shall be provided to the pipe for rodding in case of blockage.

Outlet
Pipes such as those that are used for recycling effluent to use as flush water and irrigation intakes shall be placed as far from the inlet pipes as possible in order to provide a cleaner effluent for flushing and to reduce odors when irrigating on land.

When these pipes are to be placed through the embankment, the location and method of installation shall be approved by the designer of the embankment or a technical specialist designated by the Soil and Water Conservation Commission to design and approve waste treatment lagoons.

Installation shall be certified by the technical specialist.

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.

Where excess effluent is not removed from the lagoon by pumping, an overflow pipe shall be installed to discharge into another lagoon or a waste storage pond. The overflow pipe shall have a minimum diameter of 6 inches and shall have sufficient capacity to prevent overtopping of the lagoon during peak inflow periods. The overflow pipe shall be installed so that effluent is discharged from a minimum of 6 inches below the surface. An “elbow” or “tee” pipe fitting or similar device on the inlet end of the overflow pipe may be used for this purpose.

When pumps or sumps are needed to lift water from a lower elevation to a higher elevation, provisions must be made to prevent overflow of the sump in case of power or pump failure. The sump shall be covered or fenced for safety.

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.

Emergency Spillway
Lagoons having a maximum design liquid level of 3 feet or more above natural ground shall be provided with an emergency spillway. The crest of the emergency spillway shall be located at an elevation located higher than the required volume of the lagoon. The emergency 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.

The emergency spillway shall pass a 25- year, 24-hour storm without overtopping the embankment. There shall be a minimum of 1 foot of freeboard above the designed depth of flow in the emergency spillway. Where lagoons empty into waste storage ponds or secondary lagoons and the liquid level is positively controlled by an adequately sized overflow pipe, no emergency spillway is required for the primary lagoon.

All lagoons with 1 million cubic feet of waste storage volume (volume below maximum operating level, elevation for pump ON) shall have an emergency spillway. Lagoons less than 1 million cubic feet of waste storage volume are not required to have an emergency spillway; however, the landowner shall be given the option to install an emergency spillway to prevent catastrophic occurrences.

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

Erosion Protection
Embankments and disturbed areas surrounding the lagoon shall be treated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner. Permanent vegetation shall be established on all disturbed areas in accordance with Critical Area Planting (Code 342). Plans for waste treatment lagoons shall include temporary measures for the control of erosion and sedimentation during the construction period. Such measures shall be maintained for efficient operation.

Waste removal
Provide components for removing waste such as gates, pipes, docks, wet wells, pumping platforms, retaining walls, or ramps. Incorporate features to protect against erosion, tampering, and accidental release of stored waste as necessary. Design ramp slopes to accommodate anticipated equipment and traction available. Use NRCS CPS Nutrient Management (Code 590) for land application of stored material or follow other disposal options outlined in a comprehensive nutrient management plan (CNMP).

Accumulated solids removal
To preserve lagoon storage volume, make provision for periodic removal of accumulated solids. The anticipated method for solids removal must be accommodated in design, particularly in determining the configuration of impoundments and the type of liner to be used.

Maximum operating level
The maximum operating level for liquid storage lagoon structure is the level that provides the operational volume.

Staff gauge
Place a staff gauge or other permanent marker in the waste treatment lagoon to clearly indicate the following elevations:

- Maximum operating level (top of the operational volume)
- Emergency level (top of the operational volume plus the emergency volume)
- Minimum operating level (maximum operational drawdown level that provides MTV for anaerobic lagoons plus the volume of accumulated sludge between sludge removal events)

For lagoons where the contents are not visible and a staff gauge would not be visible, identify the method for the operator to measure the depth of accumulated waste in the operation and maintenance (O&M) plan.

Safety
Include appropriate safety features to minimize the hazards of the facility (refer to American Society of Agricultural and Biological Engineers (ASABE) Standard EP470, Manure Storage Safety, for guidance).

Provide warning signs, fences, ladders, ropes, bars, rails, and other devices as appropriate, to ensure the safety of humans and livestock. Provide ventilation and warning signs for covered lagoons, as necessary, to prevent explosion, poisoning, or asphyxiation.

Design covers and grating over openings such that livestock or humans cannot accidentally displace them and fall into the facility.

Design pipelines with a water-sealed trap and vent, or similar device, if there is a potential for gases from the pipe to accumulate in confined spaces.

Place a fence around impoundments. Use NRCS CPS Fence (Code 382) for design of a fence that will prevent accidental entry by people or animals likely to be onsite. Post universal warning signs to prevent children and others from entering the lagoon.

Roofs and covers
Use NRCS CPS Roofs and Covers (Code 367) for design of the lagoon cover or roof, as needed.

Treated wood
Use criteria from NRCS CPS Roof and Covers (Code 367) for treated wood and fasteners.

Bottoms and Edges
Locate the impoundment bottom elevation a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, impoundment seepage rate and non-encroachment of the water table by contaminants. The water table may be lowered by use of drains to meet this requirement

The bottom of all lagoons shall be approximately level. The side slopes of all lagoons shall be uniform from top to bottom and shall be stable for existing soil conditions.

Scarify the bottom and cut slopes of the lagoon a minimum depth of 6 inches and compact to decrease the permeability of the soil. Compaction shall be with a sheepsfoot roller or tamping roller.

Structural design
Use criteria from NRCS CPS Waste Storage Structure (Code 313) for embankment, excavation, spillway, foundation, outlet, and structural design.

Embankments
The minimum elevation of the top of the settled embankment shall be 1 foot above the lagoon's maximum design water surface. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent.

The minimum top widths are shown in Table 2. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two- way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. When the embankment top is used as a road, provisions shall be made for protecting the emergency spillway from damage.

Table 5 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
up to 20	10
20 – 24	12
24 – 30	14
30 – 35	15

The side slopes of the settled embankment shall not be less than 3:1. All slopes must be designed to be stable.

Compaction of the 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:

- Layers of fill shall not exceed 9 inches in thickness before compaction.
- Route 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 loaded equipment traveling in a direction parallel to the main axis of the fill.

- Clayey soils shall be compacted with a “sheepsfoot” or tamping roller. (See AWMFH Appendix 10D).

A qualified inspector designated by the designer must be on site during construction, as necessary, to verify proper construction. Testing will be required as deemed necessary by the inspector and/or designer.

When testing is required, the owner will be responsible for furnishing test results and certification that the fill meets the design requirements. All tests and certification shall be performed by a certified laboratory.

If needed to protect the face of the embankment, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation shall be provided (TR- 56 and TR-69).

Excavations
Unless supported by a soil investigation, excavated side slopes shall be no steeper than 3:1.

Seepage control
Where seepage will create a potential water quality problem, provide a liner which meets the requirements of NRCS CPSs Pond Sealing or Lining - Compacted Soil (Code 520), Pond Sealing or Lining – Concrete (Code 522), or Pond Sealing or Lining – Geomembrane or Geosynthetic Clay Liner (Code 521). **NOTE:** NRCS CPS Code 521 is included in this Federal Register notice and will replace the current CPS Pond Sealing or Lining - Flexible Membrane (Code 521a).

A cutoff of relatively impervious material shall be provided under the embankment if necessary for seepage control. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable embankment when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations, and the side slopes shall be 1:1 or flatter.

All foundation cutoffs shall be dewatered before backfilling.

Additional Criteria for Anaerobic Lagoons

Loading rate
Design anaerobic lagoons to have an MTV based on the volatile solids (VS) loading per unit of volume (per 1000 ft³ of lagoon volume). Use actual loading rate data if available (refer to Table 6). Otherwise, follow the maximum loading rates in NRCS AWMFH, Figure 10-27, or State regulatory requirements, whichever is more stringent.

Minimum operating level
Provide a minimum operating level (also referred to as the maximum operational drawdown) that provides volume for the required MTV plus the volume of accumulated sludge between sludge removal events. The proper operating range of the lagoon is above the maximum operational drawdown level and below the maximum operating level. Waste lagoons can be drawn down for sludge removal as described in the O&M plan.

The maximum operating level shall be a sufficient distance below any pipe or emergency spillway to provide storage for the 25-year, 24-hour precipitation on the lagoon surface plus a heavy rainfall equal to or greater than an additional 25- year, 24-hour storm. The minimum operating level after drawdown shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events except when the lagoon is in drawdown to permit sludge removal or addition of dilution water.

Depth requirements
The minimum depth for the planned maximum residual solids plus the minimum treatment volume is 6 feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum operational drawdown, a lesser depth may be used if the volume requirements are met.

Sludge

Any anaerobic lagoon will accumulate significant amounts of sludge regardless of the bacterial digestion efficiency. This accumulation of sludge in time will diminish the treatment capacity of the lagoon unless the lagoon is designed with enough storage capacity to avoid having to remove the bottom sludge throughout the life of the lagoon. Table 6 shows the required volume for sludge accumulation in anaerobic lagoons. The volume of sludge storage required in Table 6 is equal to approximately 5 years accumulation.

Sludge storage is required in the lagoon design. The amount of sludge accumulation shall be calculated and included in the producer's Waste Utilization Plan. The plan will include a statement that sludge will be tested before land application. The Waste Utilization Plan will include the number of acres required for land application of sludge in the future based on current agronomic rates.

Table 6. LIVESTOCK ANAEROBIC LAGOON CRITERIA

				Lagoon Liquid Capacity					
Animal Type	Unit[a]	Average Live Animal Weight	Feces, Urine and Excess Wash Water[b]	Design Treatment Volume		Sludge Storage Volume[c,d]		Temp. Storage	Total Volume
		lbs	gal/day	ft^3/lb	ft^3/unit	ft^3/lb	ft^3/unit		
Dairy	head	1400	22.0	1.0	1400		1300	*	**
Beef	head	800	6.6	0.75	600		530	*	**
Veal	head	200	1.9	0.75	150		145	*	**
Swine									
Wean/Feed	head	30	0.5	1.0	30	0.25	7.5	*	**
Feed/Fin	head	135	2.3	1.0	135	0.25	34	*	**
Far/Wean	sow	433	7.2	0.67	290	0.17	74	*	**
Far/Feed	sow	522	8.0	0.67	350	0.17	89	*	**
Far/Fin	sow	1417	23.0	1.0	1417	0.25	354	*	**
Gilt Dev.	head	150	2.5	1.0	150	0.25	37.5	*	**
Boar/Stud	head	400	6.7	0.5	200	0.125	50	*	**
Poultry									
Layer	bird	4.0	0.045	2.5	10		1.1	*	**
Pullet	bird	1.5	0.017	2.5	3.8		3.2	*	**

[a] One-time animal or bird capacity

[b] Does not include fresh flush water or drainage area runoff

[c] No manure solids removal prior to lagoon input

[d] Sludge accumulation for approximately 5 years. Accumulation rates are without solids removal

* Temporary storage consists of 1) manure and wastewater, 2) excess wash water, 3) precipitation in excess of evaporation, 4) 25-year, 24-hour storm, 5) "Heavy Rain" Factor, 6) additional storage, if any

** Total (Required) volume consists of design treatment volume, sludge storage, and temporary storage. Does not include freeboard and depth of flow in spillway (if applicable, depth of flow equals 25-year, 24-hour storm)

Additional Criteria for Naturally Aerobic Lagoons

Loading rate

Design naturally aerobic lagoons to have a minimum treatment surface area as determined on the basis of daily BOD5 loading per unit of lagoon surface. The required minimum treatment surface area is the surface area at maximum sludge storage. The maximum loading rate is as indicated by AWMFH Figure 10-30 or according to State regulatory requirements, whichever is more stringent.

Depth requirements

Use a maximum operating level of between 2 and 5 feet.

Additional Criteria for Mechanically Oxygenated Lagoons

Loading rate

Design mechanically oxygenated waste treatment lagoons on the basis of daily BOD5 loading and oxygenation equipment manufacturer's performance data for oxygen transfer and mixing. Select oxygenation equipment to provide a minimum of 1 pound of oxygen for each pound of daily BOD5 loading.

Operating levels

The maximum operating level is the lagoon level that provides the required lagoon volume and must not exceed the site and oxygenation equipment limitations. The proper operating range of the lagoon is below the maximum operating level and above the minimum treatment elevation established by the manufacturer of the oxygenation equipment. Waste lagoons can be drawn down for sludge removal as described in the O&M plan.

CONSIDERATIONS

For exposed liners utilizing high-density polyethylene (HDPE) or similar materials that are slippery when wet, consider the use of textured liners or addition of features such as tire ladders that would allow for escape from the waste storage structure.

Consider solid/liquid separation of runoff or wastewater entering impoundments to minimize the frequency of accumulated solids removal and to facilitate pumping and application of the stored waste.

Since the economics and risks associated with waste treatment lagoons are quite high, consider providing the operator with the cost to close the facility. Cost should include removal of the planned sludge accumulation volume and the waste stored at the maximum operating volume. See NRCS CPS Waste Facility Closure (Code 360) for guidance.

Consider the required energy usage of any mechanically oxygenated lagoon since energy usage can be quite high.

Considerations for Siting

Consider the following factors in selecting a site for waste treatment lagoons:

- Proximity of the waste treatment lagoon to the source of waste
- Access to other facilities
- Ease of loading and unloading waste
- Compatibility with the existing landforms and vegetation, including building arrangement, to minimize odor impacts and adverse impacts on visual resources
- Adequate maneuvering space for operating, loading, and unloading equipment
- If the site is within a known karst area

Considerations for Minimizing the Potential for and Impact of Sudden Breach of Embankment or Accidental Release from the Waste Treatment Lagoon

Consider features, safeguards, and management measures to minimize the risk of failure or accidental release, or to minimize or mitigate impact of this type of failure when any of the categories listed below might be significantly affected.

Potential impact categories from breach of embankment or accidental release include—

- 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 archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

Either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments, consider—

- An auxiliary (emergency) spillway.
- Additional freeboard.
- Storage for wet year rather than normal year precipitation.
- Reinforced embankment— such as, additional top width, flattened, and armored downstream side slopes.
- Secondary containment.
- Double liners.

Options to consider to minimize the potential for accidental release from the waste treatment lagoon through gravity outlets include—

- Outlet gate locks or locked gate housing.
- Secondary containment.
- Alarm system.
- Another non-gravity means of emptying the waste treatment lagoon.

Considerations for Minimizing the Potential of Waste Treatment Lagoons Liner Failure

Avoid sites with categories listed below unless no reasonable alternative exists. Potential impact categories for liner failure are—

- Any underlying aquifer is at a shallow depth and not confined.
- The vadose zone is rock.
- The aquifer is a domestic water supply or ecologically vital water supply.
- The site is located in an area of water soluble bedrock such as limestone or gypsum.

For a site with one or more of these site conditions, consider providing a leak detection system in conjunction with the planned liner to provide an additional measure of safety.

Considerations for Improving Air Quality

Liquid manure storage may result in emissions of volatile organic compounds, ammonia, hydrogen sulfide, methane, nitrous oxide, and carbon dioxide.

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, particulate matter, and odor, other NRCS CPSs such as Anaerobic Digester (Code 366), Roofs and Covers (Code 367), Waste Treatment (Code 629), Amendments for Treatment of Agricultural Waste (Code 591), Composting Facility (Code 317), Waste Separation Facility (Code 632), and Air Filtration and Scrubbing (Code 371) can be added to the waste management system.

Adjusting pH below 7 may reduce ammonia emissions from the waste treatment lagoon but may increase odor when waste is surface-applied—see NRCS CPS Nutrient Management (Code 590).

Some fabric and organic covers have been shown to be effective in reducing odors.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended use. As a minimum, include the following in the engineering plans and specifications:

- Plan view of system layout
- Structural details of all components, including reinforcing steel, type of materials, thickness, anchorage requirements, lift thickness
- Locations, sizes, and type of pipelines and appurtenances
- Requirements for foundation preparation and treatment
- Vegetative requirements
- Quantities
- Approximate location of utilities and notification requirements
- Details of signage, fencing, and other safety features, as needed

OPERATION AND MAINTENANCE

Develop an O&M plan that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. At a minimum, the plan will contain where appropriate—

- Operational requirements for emptying the waste treatment lagoon including the expected storage period. Begin removal of the liquid from the waste treatment lagoon as soon as practical after the maximum operating level has been reached. Also 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.
- Include an explanation of the staff gauge or other permanent marker to indicate the maximum operating level and the maximum operational drawdown.
- A provision for emergency removal and disposition of liquid waste in the event of an unusual storm event that may cause the waste treatment lagoon structure to fill to capacity prematurely.
- Instructions as needed for ventilating confined spaces according to ASABE standard S607, Venting Manure Storages to Reduce Entry Risk.
- An emergency action plan for lagoons where there is a potential for significant impact from breach or accidental release. Include site-specific provisions for emergency actions that will minimize these impacts.
- A description of the routine maintenance needed for each component of the facility. Also include provisions for maintenance that may be needed as a result of waste removal or material deterioration.
- Instructions for keeping records on sludge accumulation and removal of sludge when the sludge accumulation reaches the maximum residual solids storage level.

An Emergency Action Plan shall be prepared for each lagoon. The plan will outline steps to be followed in case of an emergency with the lagoon such as overflow, breaching, leakage, need for emergency land

application, etc. As a minimum, it will contain the following items for the owne r/operator to carry out in the event of an emergency:

- Call the Division of Water Quality (DWQ) to report the problem. Include name and phone number of the appropriate regional office. If outside normal business hours, call the NC Emergency Management Office in Raleigh and ask them to contact DWQ. Give the name of the facility, location and DWQ registration/certification number.
- Call 911 or the Sheriff's Department if there is danger to downstream property (residences, road, etc.). Include phone number.
- Contact contractor(s) of owner's choice to begin repair of problem to minimize off -site damage. Include names and phone number(s).
- Contact the technical specialist who certified the lagoon. Include phone number. If this specialist is no longer working, contact one who has design approval.
- A copy of this plan containing current telephone numbers must be available at each site. It should be posted in a readily available location.

Additional O&M requiremtns for Anaerobic Lagoons

- Include instructions for anaerobic lagoons for including a precharging volume at lagoon startup or following sludge removal. Precharge the anaerobic lagoon with fresh water equal to the MTV prior to volatile solids loading.
- Provide instruction on timing removal and spreading of wastewater in a manner that will reduce odor released.

REFERENCES

American Society of Agricultural and Biological Engineers. 2011. Manure Storage Safety. ANSI/ASAE EP470. 1 FEB 2011 (R2011). ASABE, St. Joseph, MI.

American Society for Testing and Materials. Annual Book of ASTM Standards. Standards D 653, D 698, D 1760, D 2488. ASTM, Philadelphia, PA.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2012. National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook. Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. National Engineering Manual. Washington, DC.

North Carolina Dam Safety Law. 2017. Senate Bill 107 / S.L. 2017-145