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.
- Where livestock are concentrated.
- 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. (NRCS Classification is Class (a))

CRITERIA

General Criteria for All Lagoons

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

If the embankment is over 15 feet high and impounds over 10 acre-feet of effluent, a permit must be obtained as required by the North Carolina Dam Safety Law.

Location. To minimize the potential for contamination of streams, lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. **LAGOONS 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.

Minimum Distance Table 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 [1]
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.

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

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 • 500 ft. from any well that supplies water for human consumption on property not owned or controlled by the swine producer
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 or canal

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

NRCS, NC

February 2009

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

- New or emptied lagoons shall be precharged 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 35 feet are to be designed under this standard. See Engineering Notekeeping, Pond (Code N378) or National Engineering Manual (NEM) 520.21 for guidance concerning documentation of hazard class determination.

Emergency Action Plan. 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 owner/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.

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 type of swine farm and the design capacity of the animal waste management system.*
3. *The name and address of the technical specialist preparing the waste management plan.*
4. *The address of the local Soil and Water Conservation District Office.*
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 1.25×10^{-6} cm/sec (0.003 ft/day).

Treatments or liners shall meet or exceed the requirements of Pond Sealing or Lining, Soil Dispersant Treatment (Code 521B), Bentonite Sealant (Code 521C) or Compacted Clay Treatment (Code 521D).

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

Required Volume. The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events;
- Minimum treatment volume (anaerobic lagoons only);
- Volume of manure, wastewater, excess wash water, and other wastes accumulated during the treatment period;
- Depth of normal precipitation less evaporation on the surface area (at the required volume level) of the lagoon and any other contributing area during the treatment period for the time of year which results in the greatest storage requirement;
- Depth of the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon and any other contributing area.
- Depth of additional “Heavy Rain” factor, which exceeds the long-term rainfall average. This “Heavy Rain” factor shall be equal to or greater than the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon and any other contributing area.
- Additional temporary storage may be provided to meet management goals or regulations.

In soils with high water table, all temporary storage shall be above the seasonal high water table.

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.

Waste Loading. Daily waste loading shall be based on the maximum daily loading of the maximum Steady State Live Weight (SSLW) of the animals, considering all waste sources that will be treated by the lagoon. Reliable local information or laboratory test data should be used if available. Information

on waste production is available in AWMFH Chapter 4.

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 1. LIVESTOCK FRESH MANURE CHARACTERISTICS

	Average Animal Weight	Manure Production (Feces & Urine)		Nitrogen		Phosphorus P_2O5	Potassium K_2O
				Total N	Ammonia NH_3N		
	(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
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

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

NRCS, NC

February 2009

Foundation Cutoff (Keyway, Cutoff or Core Trench). 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.

Bottoms and Edges. 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.

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 2 – 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.

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. 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 Waster 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.

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. In addition, the lagoon shall be fenced, if necessary, to protect the vegetation and embankment.

Additional Criteria for Anaerobic Lagoons

Loading Rate. Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per 1000 ft^3 of lagoon volume. The maximum loading rate shall be as indicated in AWMFH Figure 10-22 (page 10-29), Table 3, or according to state regulatory requirements, whichever is more stringent.

Operating Levels. 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.

Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the minimum operating level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 6 feet. The maximum depth is dictated by the site and equipment.

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 3 shows the required volume for sludge accumulation in anaerobic lagoons. The volume of sludge storage required in Table 3 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 3. 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)

\# Minimum volume for dairy and beef may be decreased when solids are removed

Animal weights are expressed as average values for the purpose of lagoon design.

NRCS, NC

February 2009

Additional Criteria for Naturally Aerobic Lagoons

Loading Rate. Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD_5 loading per acre of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate for North Carolina is 50 lbs. of BOD_5 per acre per day as indicated by AWMFH Figure 10-25 (page 10-26) or according to state regulatory requirements, whichever is more stringent. One 1400 lb. dairy cow requires 2000 ft^2 of surface area while one finishing hog requires 365 ft^2.

Operating Levels. 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 shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the minimum operating level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 2 feet. The maximum liquid level shall be 5 feet.

Additional Criteria for Mechanically Aerated Lagoons

Loading Rate. Mechanically aerated lagoons using floating surface aerator technology for odor control are designed to satisfy 50% of the waste COD based on an oxygen transfer rate of 3 lbs. per horsepower-hour and require 1000 ft^2 of surface area maximum per horsepower of aeration. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD_5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD_5 loading.

Operating Levels. 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 and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 6 feet. The maximum depth is dictated by the site and equipment.

CONSIDERATIONS

General

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 facility access, ease of loading and unloading waste, economics, the overall waste management system plan, and safety and health factors.

Type

Waste treatment lagoons are of three general types -- anaerobic, naturally aerobic, and 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.

Anaerobic lagoons are most commonly used for livestock waste treatment

Since the anaerobic process is not dependent on maintaining free oxygen, lagoons can be deeper and require less surface area. Anaerobic decomposition of livestock waste can result in the production and emission of odorous gases; however, an anaerobic lagoon that is properly sized can be managed to keep odors to a minimum. Figure A is an example of a typical anaerobic lagoon.

Naturally aerobic lagoons tend to be relatively odor free because bacterial digestion tends to be more complete. Aerobic lagoons are designed on the basis of surface area instead of volume. Aerobic lagoons may require up to 25 times as much land area as anaerobic lagoons and are usually not recommended for livestock and poultry waste treatment in North Carolina because of space requirements.

Mechanically aerated lagoons combine the best features of aerobic and anaerobic; that is, good odor control with small surface area requirements. They may also be used for nitrogen removal where land area for disposal is limited. The major disadvantage of mechanically aerated lagoons is the high cost of electric energy for continuous operation of the aerators.

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. The sizing of these structures will be such that a waste utilization plan can be developed. If earth structures are used, a minimum of two should be planned so that one can be dried and cleaned while the other is functioning.

Organic nitrogen compounds and phosphorus compounds tend to accumulate in sludge. In addition to nitrogen levels up to 13 times higher than lagoon liquid and phosphorus levels up to 45 times higher than lagoon liquid concentrations, sludge may also contain significant levels of heavy metals, salts, and other trace elements.

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 4 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 4 may be significantly affected:

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

- Water level indicators or recorders

The following should be considered to

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

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 4 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 5 may be affected.

Should any of the potential impact categories

Table 5 - 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)

listed in Table 5 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 1×10^{-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, Waste Storage Facility (Code 313), for fabricated structures requiring water tightness.

Considerations for Improving Air Quality

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

- Reduce the recommended loading rate for anaerobic lagoons to one-half the values given in AWMFH Figure 10-22.
- Use additional practices such as Anaerobic Digester – Ambient Temperature (Code 365), Anaerobic Digester – Controlled Temperature (Code 366), Waste Facility Cover (Code 367) and Composting Facilities (Code 317) in the waste management system.
- Liquid/solid separation prior to discharge to lagoon will reduce volatile solids (VS) loading resulting in reduced gaseous emissions and odors. Composting of solids will further reduce emissions.
- Design lagoons to be naturally aerobic or to allow mechanical aeration.

Adjusting pH below 7 may reduce ammonia emissions from the lagoon but may increase odor when waste is surface applied (See Waste Utilization, (Code 633)).

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Plans and specifications for a waste treatment lagoon will only be prepared when it is a part of a complete waste management system including a waste utilization plan.

OPERATION AND MAINTENANCE

A written Operation and Maintenance (O&M) Plan shall be prepared for each lagoon. The O&M Plan shall be incorporated into the design prepared for the Waste Management System. A copy will be given to the landowner and discussed with him/her. As a minimum, the O&M Plan shall contain the following:

1. A waste utilization plan that is in accordance with Waste Utilization (Code 633) and Nutrient Management (Code 590). Note: A more detailed plan may be required if controlling nutrient is other than nitrogen.
2. Precharge with a volume of water equal to one-half of the treatment volume before wastes are introduced.
3. Highly visible markers shall be installed to mark the upper and lower elevations of the Temporary Storage (pumping volume). Pumping shall be done as necessary to maintain the liquid level between these markers.
4. Recommendations for inspection and maintenance of embankment and other structures.
5. Recommendations for inspection and maintenance of vegetation.
6. Information on sampling and testing of effluent.
7. Information on measuring, sampling, and managing the sludge accumulation in the lagoon. All removed sludge shall be land applied at agronomic rates based upon an analysis of the sludge.
8. After five years, the sludge accumulation in the lagoon shall be measured annually, or as needed, to define and document the rate of sludge accumulation in the lagoon and as directed by DWQ.
9. If sludge accumulation in the treatment volume exceeds 50% of the planned treatment volume, the sludge should be either removed or the lagoon managed in accordance with an approved Sludge Management/Operation Plan as approved by DWQ. The Plan shall be sufficient to insure that the functionality of the lagoon/waste treatment system is maintained and that effluent is applied in accordance with NRCS Waste Utilization (CPS Code 633) and such additional operational permitting requirements as may be issued by DWQ.
10. Sludge Management Guidance – Lagoon evaluation data developed by NCSU and a review of lagoon management records of several lagoons showed that the treatment capability of the swine lagoons evaluated in NC was not significantly adversely affected by sludge accumulations of 50% or more of the planned treatment volume of the lagoon. Therefore it is felt that it is permissible to allow sludge accumulation into the planned treatment zone of properly monitored and managed lagoons, provided that:

    - Nutrient values of the lagoon effluent are within the normal operating range.
    - There is no noticeable increase in lagoon odor.
    - Nutrients land applied from the lagoon are properly accounted for in the application plan (WUP).

    Sludge Management Plans shall, as a minimum, address the following:

    - Adequate monitoring to define sludge volume, location, and rate of accumulation.
    - Maintain a minimum 2.5 ft. deep zone, free of sludge, at the pump intake during irrigation.
    - Position the pump intake and manage the irrigation operation such that the material irrigated is not more concentrated than the nutrient analysis samples.
    - Sufficient monitoring to address concerns that nutrients are not over applied.
    - Other items as required by DWQ.
11. Other operation and maintenance items, as appropriate for the site.

Temporary Adjustments

The O&M procedure may be modified to allow an optional, temporary, adjustment in the lagoon operating procedure. This adjustment in operating procedure allows the operator to pump into the top 8 inches of the treatment volume during the period of June 15 through October 31 to provide:

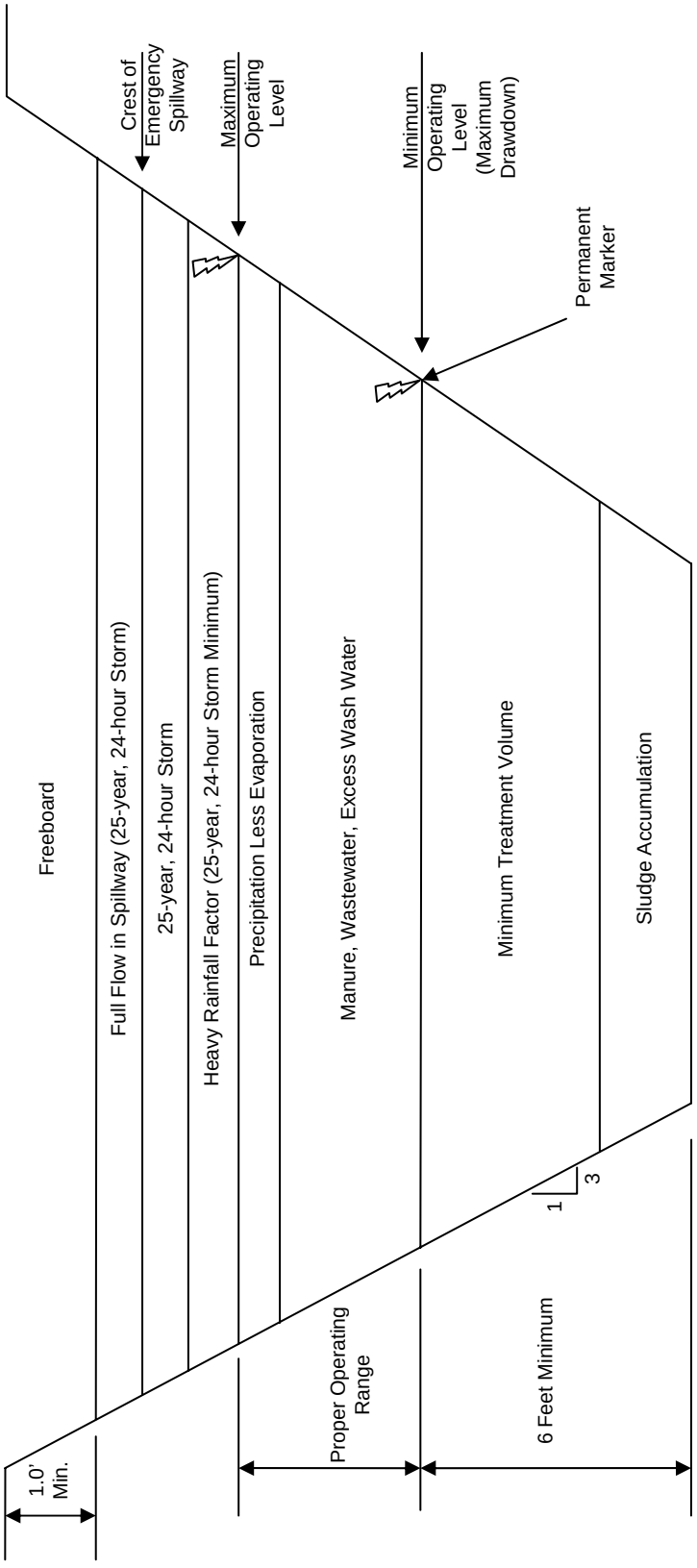
- Irrigation water during drought periods to establish or maintain vegetation in waste application areas.
- Additional temporary storage for excessive rainfall during the hurricane season and the following winter months.

The following restrictions shall apply:

1. Lagoon levels may be lowered a maximum of 8 inches below the facility's stop pump mark during the period of June 15 through October 31.
2. This option shall be limited to lagoons having a minimum of 4 feet of liquid above the sludge layer. The measurement shall be taken from the stop pump level, at the pump intake, prior to pumping below the stop pump level.
3. All applications must be in conformance with the CAWMP developed for the operation, including adherence to the planned nutrient application rates.
4. From November 1 through June 14, pumping from the lagoon will not be permitted when the lagoon level is at or below the stop pump elevation.
5. The following information concerning the pump down condition shall be recorded and maintained on site:

    - Date the lagoon was first pumped below the stop pump level.
    - Depth of liquid between the stop pump level and the sludge layer prior to pumping below the stop pump mark. Measured from the stop pump level near the pump intake location but off the inside slope of the embankment.
    - Date pump down was completed.
    - Depth of pump down below the stop pump level. Measured weekly until the lagoon returns to the stop pump level.

- **Figure A - Anaerobic Lagoon Cross Section**



The minimum treatment volume is based on Volatile Solids.

Crest of Emergency Spillway can be any Outflow Device.

NRCS, NC

February 2009