NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(No.)

CODE 313

DEFINITION

A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

PURPOSE

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a storage function component of an agricultural waste management system (AWMS).

CONDITIONS WHERE PRACTICE APPLIES

Where the storage facility is a component of a planned AWMS.

Where temporary storage is needed for organic wastes generated by agricultural production or processing.

Where the storage facility can be constructed, operated, and maintained without polluting air or water resources.

Where site conditions are suitable for construction of the facility.

To facilities 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.

To fabricated structures including tanks, stacking facilities, pond appurtenances, and roof structures.

This practice does not apply to storage of human domestic sewage or wastewater.

CRITERIA

General Criteria Applicable to All Waste Storage Facilities.

Laws and Regulations. Waste storage facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations.

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

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

Location. Waste storage facilities shall not be located within the 100-year flood plain unless the structure is protected from inundation and damage that may occur during the 100-year flood event. For a structure to be protected from inundation, the lowest part of the top of the storage structure or floor of a roofed structure shall be at least 1 foot above the water surface elevation of the 100-year flood.

The water surface elevation of the 100-year flood can be determined by using Federal Emergency Management Agency (FEMA) 100-year floods, United States Geological Survey (USGS) 100-year flood prone maps, and/or completing a hydrologic and hydraulic analysis. If no FEMA or USGS 100-year flood delineation is available for the location of the waste storage structure, the 100-year flood elevation must be

determined by completing a hydrologic and hydraulic analysis.

To determine the 100-year flood elevation using a hydrologic and hydraulic analysis, a 100-year flow must first be estimated by using USGS published peak-flow 100-year frequency estimates, using USGS flow-frequency regression equations, or utilizing a rainfall runoff model. If using a rainfall runoff model, a 100 year frequency, 24-hour duration storm peak flow estimate shall be determined. Manning's equation or a step-backwater program such as Hec/Ras must then be used to determine the 100-year flood elevation corresponding to the 100-year flow estimate.

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

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

Waste storage facilities 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.

Storage Period. The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and federal regulations.

Storage facilities that receive drainage from open lots must store at least 365 days of manure, wastewater, and contaminated runoff produced by the livestock operation. Storage facilities that do not receive drainage from open lots must store at least 270 days of manure and wastewater, except facilities emptied only once per year must store at least one-year of waste.

Design Storage Volume. Design storage volume shall consist of the total of the following as appropriate:

(A) Residual volume at the bottom of the storage structure. A minimum of 6 inches shall be provided for tanks and 12 inches for all facilities constructed of earthen materials;

(B) Manure, wastewater, and other wastes accumulated during the storage period;

(C) Average runoff from the facility's drainage area during the storage period less evaporation calculated on the surface of the pond at the average active storage depth (depth midway between the top of the residual and the maximum operating level) during the storage period;

(D) Average annual precipitation falling on the area inside the top of the structure embankment;

(E) Waste storage facilities for animal feeding operations that commenced construction (or had significant expansion) after February 12, 2003, that require permitting through the SD DENR, and that involve waste from swine, poultry, or veal, must contain the 100-year frequency, 24-hour duration runoff without discharge. Storage capacity for the 100-year frequency, 24-hour duration storm precipitation on the surface area inside the tops of the containment dikes must also be contained for these systems;

(F) For waste storage facilities not described in Section E, include the 25-year frequency, 24-hour duration precipitation runoff (if the structure receives runoff from an open lot or other drainage area), and the depth of the 25-year frequency, 24-hour duration storm precipitation on the surface area inside the tops of the

containment dikes; additional storage as may be required to meet management goals or regulatory requirements (including freeboard).

Note - Uncontaminated storm water runoff shall be diverted away from the facility wherever possible. Diversions shall be designed and constructed in accordance with the SD Natural Resources Conservation Service (NRCS) Conservation Practice Standard (CPS) Diversion (362) or other appropriate SD NRCS CPS.

Freeboard. Freeboard must be included above the Design Storage Depth. Freeboard design depth for waste storage facilities constructed of earthen materials must include at least two feet of freeboard, except one foot of freeboard may be used for small ponds that do not have contributing drainage areas and that will not need SD DENR review or approval.

Fabricated structure design depth must include at least six inches of freeboard.

Additional embankment overtopping protection must be provided for embankment storage ponds that receive runoff from contributing drainage areas. Overtopping protection may take the form of embankment armoring, additional storage capacity, or an auxiliary spillway.

Where designs include auxiliary spillways, the crest of the auxiliary spillway must be at least 1 foot above design storage elevation, and settled embankment top elevation must be at least 1 foot above the water surface during passage of runoff from the 25-year frequency, 24-hour duration storm occurring when the design storage volume is filled. The auxiliary spillway may be a channel, chute structure, drop structure, or overflow pipe. Earthen channel auxiliary spillways must have four foot minimum bottom width. Chute and drop structure spillways must have four foot minimum weir width. Overflow pipes must have six inch minimum nominal diameter. Auxiliary spillway outflows must not be directed onto property not owned by the owner/operator, within 250 feet of the structure.

All embankment storage ponds without an auxiliary spillway must have the required freeboard described above and must not be overtopped by the runoff from a 25-year frequency, 24-hour duration storm occurring when the design storage volume is filled.

Minimum freeboard for facilities permitted by the SD DENR must also meet state regulations.

Maximum Operating Level. The maximum operating level for waste storage facilities shall be the level that provides the volume required by Sections A-D in the Design Storage Volume section.

A permanent marker or recorder shall be installed at this maximum operating level to indicate when drawdown should begin. The marker or recorder shall be referenced and explained in the Operation and Maintenance (O&M) Plan.

Active Storage Volume and Depth. The active storage volume is defined as the volume included in Sections B, C, and D in the Design Storage Volume section. Active Storage Depth is defined as the pond depth that includes the volumes for Section B, C, and D in the Design Storage Volume section.

Volume Reduction by Evaporation. Waste storage facilities designed to emphasize significant reduction of liquid volume through evaporation must only contain contaminated liquid (not solids). Manure or other solid wastes must be stored in a separate waste storage facility. A sediment basin designed according to SD NRCS CPS Sediment Basin (350) or other solids removal method designed according to an appropriate SD NRCS CPS must be used to minimize entry of solids into the evaporation facility.

Dimensions of the evaporation facility will be determined by evaluating the expected annual runoff volume from the contributing area, the annual rainfall volume on the pond, and the expected annual evaporation volume calculated at the midpoint elevation of the active storage depth as defined above.

Active storage volume for evaporation designs must contain the average annual runoff and precipitation volume minus the mean annual shallow lake evaporation volume multiplied by five.

As described by:

Active Storage Volume =

((Average annual runoff and precipitation volume) – (mean annual shallow lake evaporation)) * 5.

A minimum of one foot of depth must be provided for the active storage depth.

The requirements to provide storage for large storm events above the maximum operating level (Design Storage Volume Sections E and F) and to provide freeboard also apply to facilities emphasizing evaporation.

Recommended Minimum Liquid Surface Area for Evaporation Facilities.	
Average Annual Precipitation, Inches	**Ratio, Pond Bottom Area/Drainage Area**
<18"	0.12
18"-20"	0.15
20"-22"	0.18
22"-24"	0.22
24"-26"	0.30
>26"	0.33

The O&M Plan for each evaporation facility shall include specific language to explain that pumping (partial emptying) will be necessary to maintain required storage capacity during periods of wet climatic conditions. Pumping the pond down to at or below the maximum operating level is required when the level in the pond exceeds the maximum operating level. The O&M Plan should also address maintaining the moisture content of the bottom and inner side slopes of the facility during drought to reduce cracking and future seepage losses.

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.

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

The use of corrugated polyethylene pipe or corrugated polypropylene pipe are not allowed as inlets or outlets. Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking. The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16-gage as appropriate for the particular pipe material. Design information concerning the acceptable maximum height of earthfill over various pipe materials used in earthen embankments is shown in the following table. Minimum earthfill cover over pipes should also be considered especially in areas of heavy vehicle traffic. Calculations made by an engineer are required for any deviation from the following table.

Acceptable Plastic Pipe for Use in Earth Embankments

Pipe Material	Testing Method Designation	SDR / Pressure Rating and/or Schedule	Applicable Pipe Diameters (inches)	Maximum Fill Height Above Pipe (feet)
PVC 1120/1220 Plastic Irrigation Pipe (PIP)	ASTM D2241	SDR 26 - 160 psi	8, 10, 12, 14, 15, 18, 21, 24, 27	**10**
		SDR 21 - 200 psi	(15)	**18**
PVC and ABS 1120/1220/2120 Iron Pipe Size (SDR-PR) (IPS)	ASTM D2241	SDR 26 - 160 psi	8, 10, 12, 14, 16, 18, 20, 24, 30, 36	**10**
		SDR 21 - 200 psi	8, 10, (12, 14, 16, 18, 20, 24, 30, 36)	**18**
		SDR 17 - 250 psi	(8, 10, 12, 14, 16, 18, 20, 24, 30, 36)	**30**
PVC Schedule 40 & 80	ASTM D1785	Schedule 40 - SDR varies with diameter	8, 10, 12, (14, 16, 18)	**8**
			(20 & 24)	**6 ***
		Schedule 80 - SDR varies with diameter	8	**28**
			10	**26**
			12 & (14)	**24**
			(16 & 18)	**22**
			(20 & 24)	**20**
PVC Plastic Pipe, Iron Pipe Size (IPS) O.D. dia. Controlled	AWWA C905	SDR 26 - 160 psi	14, 16, 18, 20, 24, 30, 36	**10**
		SDR 21 - 200 psi	14, 16, 18, 20, 24, 30, 36	**18**
PVC Plastic Pipe, Iron Pipe Size (IPS)	AWWA C900	SDR 25 - 100 psi	8, 10, & 12	**4**
		SDR 18 - 150 psi	8, 10, & 12	**10**
		SDR 14 - 200 psi	8, 10, & 12	**16**
Type PSM - PVC Pipe (Sewer Pipe)	ASTM D3034	SDR 26	8, 10, 12, 15	**10 ***
PE Schedule 40 Plastic Pipe	ASTM D2447	Schedule 40 - SDR varies with diameter	(8)	**5 ***
			(10)	**4 ***
Polyethylene Plastic Pipe (SDR-PR) O.D. dia. Controlled (IPS)	ASTM D3408, D3306, D3406, D2306, D2406, D2305, & D1404	SDR 26 - Pressure Rating varies with Material	8, 10, 12, 14, 16, 18, 20, 22, & 24	**4 ***
		SDR 21 - Pressure Rating varies with Material	8, 10, 12, 14, 16, 18, 20, 22, & 24	**8**
		SDR 17 - Pressure Rating varies with Material	8, 10, 12, 14, 16, 18, 20, 22, & 24	**10**
		SDR 15.5 - Pressure Rating varies with Material	8, 10, 12, 14, 16, 18, 20, 22, & 24	**14**

*Not recommended in areas with highly plastic CL or CH Soils

Note: Pipe with diameters listed within closed parentheses may have very limited availability or will only be available with large quantity Special Orders.

Outlet. No outlet shall automatically release storage from the required design volume. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging.

Emptying Component. Some type of component shall be provided for emptying storage facilities. It may be a facility such as a gate, pipe, dock, wet well, pumping platform, retaining wall, or ramp. Features to protect against erosion, tampering, and accidental release shall be incorporated as necessary.

Accumulated Solids Removal. Provision shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the configuration of ponds and type of seal, if any.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. Ramps used to empty liquids shall have a slope of four horizontal to one vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided.

Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines 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. Gravity discharge pipes used for emptying a storage/treatment facility shall have a minimum of two gates or valves, one of which shall be manually operated.

Ponds and uncovered fabricated structures for liquid or slurry waste with fabricated walls less than five feet above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose. This fencing shall be in accordance with the SD NRCS CPS Fence (382) and the SD NRCS Range Technical Note No. 7 (Fence). This fencing shall also meet or exceed the fence specifications detailed in the SD NRCS Conservation Job Sheet 382-2 (Protective Fence).

Erosion Protection. Embankments and disturbed areas surrounding the facility shall be seeded or otherwise treated to control erosion. Seeding shall meet the Critical Area Seeding criteria located in SD Range Technical Note No. 4 and the SD NRCS CPS Critical Area Seeding (342).

Adequate erosion protection must be provided on earthen pond walls and floors where erosive flow is possible, such as below the discharge of an inlet pipe. Erosion protection devices, such as splash pads and chutes, shall have adequate capacity, shape, and orientation to handle the maximum discharge from the inlet pipes to ensure that flow is maintained within the chute.

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

Livestock Access. Livestock shall be prohibited access to the interior of waste storage facilities with the exception of the interior of roofed structures that are used to provide a portion of the required waste storage capacity.

The exception for roofed structures has been added in this revision.

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

Nutrient Management. A Comprehensive Nutrient Management Plan, which will meet the CPS Nutrient Management (590), shall be developed and implemented.

Additional Criteria for Waste Storage Ponds Soil and Foundation.

The pond shall have a bottom elevation that is a minimum of two feet above the seasonal high water table unless features of special design are incorporated that address buoyant forces, pond seepage rate, and non-encroachment of the water table by contaminants. Where SD DENR approval will be obtained, perimeter drains must meet SD regulatory requirements.

An onsite soils investigation shall be conducted in sufficient detail to determine:

- The soil type(s), based on the Unified Soil Classification System;
- The need for and extent of seepage control measures required;
- Embankment and liner design parameters;
- The location of the seasonal high water table, when one is present;
- That SD DENR requirements have been met (where applicable);

Soils information must be obtained to a minimum depth of two feet below the bottom of the proposed storage facility.

The pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the pond shall be lined. Information and guidance on controlling seepage and on in situ soils with acceptable permeability for waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D. If the in situ soils have a coefficient of permeability (hydraulic conductivity) greater than $1x10^{-7}$ $cm^3/cm^2/sec$, a constructed liner is required. Caution shall be taken when utilizing in situ soils as the pond containment in areas with a macropore structure that is conducive to high permeability.

Clay Liners. Clay liners must be at least 18 inches thick and compacted to at least 95 percent of standard maximum dry unit weight, and at water content within the range of 2 to 4 percent above optimum moisture content as determined by the ASTM D698, or as determined by site-specific samples and recommendations by a soil testing laboratory. The final compacted clay liner must have a coefficient of permeability (hydraulic conductivity) less than $1x10^{-7}$ $cm^3/cm^2/sec$. Where the SD DENR approval will be obtained, the compacted clay liner must meet SD regulatory requirements. The clay liner must extend to at least the top of the maximum operating level as defined above.

Flexible Membranes. Flexible membranes must be designed to be waterproof (including seams) and must be designed for permanent exposure to ag waste, soils, and sunlight. Flexible membranes must meet the minimum requirements contained in the NRCS CPS Pond Sealing or Lining – Flexible Membrane (521A). Thicker membranes may be required by state or local government regulatory agencies.

Embankments. The minimum elevation of the top of the settled embankment shall be high enough to include the entire design storage volume and freeboard depth as described in the sections above. Required fill height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement.

Where required compaction is less than 95 percent of ASTM D698 standard maximum dry unit weight, the fill height increase for settlement shall not be less than 5 percent. Minimum freeboard for facilities permitted by the SD DENR must meet state regulations.

Earth embankment slopes must be designed to be stable and must be three horizontal to one vertical or flatter.

The minimum top widths are shown in Table 1.

Table 1 – Minimum Top Widths

Total Embankment Height at Centerline, ft.	Top Width, Feet

19.9 or less	10
20–24.9	12
25–29.9	14
30–35	15

Note - SD DENR may require other top widths.

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

Additional Criteria for Solid Manure Storage Facilities

When storage of manure in a facility is being handled as a solid, such as with a solid manure stacking pad, the storage facility shall be designed to prevent pollution. The minimum required capacity for the portion of the manure handled as a solid for this type facility will be 270 days.

Design Storage Volume. The design storage volume for this type of facility shall consist of:

A) Manure, bedding, and other wastes accumulated.

B) For storage facilities exposed to direct precipitation, the required volumes as described in Sections C, D, E, and F of the **Design Storage Volume** Section above.

C) For storage facilities exposed to direct precipitation, the requirements as described in the Freeboard Section above.

Utilization of Vegetated Treatment Areas (VTA). Instead of containing all of the design storage volume as described in the previous section within a waste storage facility, a VTA can be used in conjunction with a solid manure storage facility to treat runoff water from solid manure storage facilities that are exposed to precipitation. The design storage for the solid manure portion for this type of facility shall be the manure, bedding, and other wastes accumulated for a minimum of 270 days. The liquid runoff from the solid storage area shall be contained within a VTA meeting the requirements of NRCS CPS Vegetated Treatment Area (635).

Solid Manure Storage Floor Requirements. Floors for solid manure storage structures shall be one of the following:

- A minimum five-inch thick concrete slab with distributed reinforcing steel and water stops in all construction joints.
- A minimum 5-inch thick concrete slab with distributed reinforcing steel placed over a 12-inch thick compacted clay liner designed according to procedures in the AWMFH, Chapter 10, Appendix 10D. A minimum four-inch thick layer of sand and gravel shall be utilized between the clay liner and concrete slab to minimize the potential for cracking of the concrete due to moisture or frost heaving.
- A minimum 5-inch thick concrete slab with distributed reinforcing steel placed over 4 inches of sand and gravel, 12-inches of earthen materials, and a flexible membrane meeting the minimum requirements contained in the NRCS CPS Pond Sealing or Lining – Flexible Membrane (521A).
- An 18-inch thick compacted clay liner designed according to procedures in the AWMFH, Chapter 10, Appendix 10D.
- A 12-inch thick layer of compacted earthen material over a flexible membrane meeting the minimum requirements contained in the NRCS CPS Pond Sealing or Lining – Flexible Membrane.

Other specific requirements as noted in the **Additional Criteria for Fabricated Structures** Section shall also be followed.

Maintaining a clay liner during normal operations and cleaning can be challenging, so provisions for maintaining the integrity of the clay liner or impermeable membrane

must be included in the O&M Plan for the facility.

Additional Criteria for Roofed Animal Production Facilities Utilized to Minimize Contaminated Runoff

When a roof structure is used to eliminate contaminated runoff, the structure shall be designed to prevent manure under the roof from becoming a pollution problem. Roofs shall be designed for the snow and wind loads found in the SEI/ASCE 7 Minimum Design Loads for Buildings and Other Structures. If full composting of manure is intended within the building, consider using the NRCS CPS Composting Facility (317).

Building Structural Requirements. All foundation or structural components will meet the requirements contained in this standard under "Criteria for Fabricated Structures."

The design and construction of the roof structure shall be approved and sealed by a professional engineer licensed to practice engineering in the State of SD.

Design Storage Volume. It is recognized that the floor area of these facilities will provide some portion of the overall waste storage capacity. The minimum required capacity for the portion of the manure handled as a solid for this type facility will be 270 days. Storage capacity for manure and bedding shall be provided within the roofed structure and/or other storage facilities, such as stacking pads.

The Design Storage Volume for Roofed Animal Production Facilities shall be the same as the Design Storage Volume as described in the **Design Storage Volume section** within the **Additional Criteria for Solid Manure Storage Facilities** Section.

Utilization of Vegetated Treatment Areas. If utilizing a VTA for runoff from solid manure storage that is associated with a roofed animal production facility, use the criteria listed within the **Utilization of Vegetated Treatment Areas** Section within the **Additional Criteria for Solid Manure Storage Facilities** Section.

Animal Space Requirements. The maximum number of animals used to determine the animal units for the barn cannot exceed the total area for animals in the barn divided by the appropriate space requirement listed below:

Dairy heifers (less than 650 pounds): 28 square ft./head

Dairy heifers (650 - 800 pounds): 32 square ft./head

Dairy heifers (800 – 1,200 pounds): 40 square ft./head

Dairy cows (more than 1,200 pounds): 50 square ft./head

Beef (less than 600 pounds): 25 square ft./head

Beef (more than 600 pounds): 35 square ft./head

As an example, if a barn has 10,000 square feet of available animal space for 1,000 pound dairy heifers, the maximum number of animals that can be housed within the barn is 250 head (10,000 square ft./40 square ft. per head = 250 head).

Roofed Structure Floor Requirements. Floors within roofed structures shall meet the requirements as described in the **Solid Manure Storage Floor Requirements section** within the **Additional Criteria for Solid Manure Storage Facilities** Section.

Additional Criteria for Fabricated Structures

Foundation. The foundations of fabricated waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads; settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be

obtained from Table 2 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Foundations consisting of bedrock with joints, fractures, or solution channels shall be treated or a separation distance provided consisting of a minimum of one foot of impermeable soil between the floor slab and the bedrock or an alternative that will achieve equal protection.

Table 2 - Presumptive Allowable Bearing Stress Values[1/]

Foundation Description	Allowable Stress
Crystalline Bedrock	12,000 psf
Sedimentary Rock	6,000 psf
Sandy Gravel or Gravel	5,000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3,000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2,000 psf
[1/]Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)	

Liquid Tightness. Applications such as tanks that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practices to achieve liquid tightness.

Structural Loadings. Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure and load combinations in compliance with this standard and applicable local building codes.

Lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in the NRCS Technical Release (TR) 74, Lateral Earth Pressures, (TR-74).

If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 3 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall meet the following:

Rigid frame or restrained wall. Use the values shown in Table 3 under the column “Frame Tanks,” which gives pressures comparable to the at-rest condition.

Flexible or yielding wall. Use the values shown in Table 3 under the column “Free-Standing Walls,” which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Equivalent fluid pressures lower than 60 lbs./ft.^{2}/ft. depth are appropriate for design only where excellent drainage is provided for backfill.

Internal lateral pressure used for design shall be 65 lb./ft.^{2} where the stored waste is not protected from precipitation. A value of 60 lb./ft.^{2} may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP 393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

If the facility is to have a roof, snow, and wind loads shall be as specified in SEI/ASCE 7 Minimum Design Loads for Buildings and Other Structures. If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

Structural Design. The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties, and construction quality. Design assumptions and construction requirements shall be indicated on standard plans.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grills or secure covers for safety and for odor and vector control.

All structures shall be underlain by free draining material or shall have a footing located below the anticipated frost depth.

A single layer of steel placed near the center of the slab or wall may be used for members that are not more than eight inches thick.

Trusses delivered to job site shall be accompanied with a certification stamped by a professional engineer showing that the truss design conforms to this standard for the building dimension shown on the drawings.

Fabricated structures shall be designed according to the criteria in the following references as appropriate:

Steel: "Manual of Steel Construction," American Institute of Steel Construction.

Timber: "National Design Specifications for Wood Construction," American Forest and Paper Association.

Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318," American Concrete Institute.

Masonry: "Building Code Requirements for Masonry Structures, ACI 530," American Concrete Institute.

Midwest Plan Service (MWPS-36) Concrete Manure Storage Handbook available from the Extension Service.

Slabs on Grade. Slab design shall consider required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required and the subgrade is uniform and dense, the minimum slab thickness shall be 4 inches with a maximum joint spacing of 10 feet. Joint spacing can be increased if designed according to American Concrete Institute, ACI 360, "Design of Slabs-on-Ground."

For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be five inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on guidelines such as American Concrete Institute, ACI 360, "Design of Slabs-on-Ground."

When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure incorporating a subgrade resistance parameter(s) such as ACI 360 shall be used.

Table 3 - Lateral Earth Pressure Values[1/]

		Equivalent Fluid Pressure (lb./ft.^{2}/ft. of depth)			
Soil		Above Seasonal High Water Table[2]		Below Seasonal High Water Table[3]	
Description[4/]	Unified Classification[4/]	Free-	Frame	Free-	Frame Tanks

		Standing Walls	Tanks	Standing Walls	
Clean gravel, sand or sand-gravel mixtures (maximum 5 percent) fines)[5/]	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt and clay mixtures (less than 50 percent fines) Coarse sands with silt and and/or clay (less than 50 percent fines)	All gravel sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
Low-plasticity silts and clays with some sand and/or gravel (50 percent or more fines) Fine sands with silt and/or clay (less than 50 percent fines)	CL, ML, CL-ML SC, SM, SC-SM	45	75	90	105
Low to medium plasticity silts and clays with little sand and/or gravel (50 percent or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50)[6/]	CH, MH	-	-	-	-

[1/]For lightly-compacted soils (85 percent to 90 percent maximum standard density.) Includes compaction by use of typical farm equipment.
[2/]Also below seasonal high water table if adequate drainage is provided.
[3/]Includes hydrostatic pressure.
[4/]All definitions and procedures in accordance with ASTM D 2488 and D 653.
[5/]Generally, only washed materials are in this category
[6/]Not recommended. Requires special design if used.

CONSIDERATIONS

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable.

Nonpolluted runoff should be excluded from the structure to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

Solid/liquid separation of runoff or wastewater entering pond facilities should be considered to minimize the frequency of accumulated solids removal and to facilitate pumping and application of the stored waste.

Due consideration should be given to environmental concerns, economics, the overall waste management system plan, and safety and health factors.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume.

Features, safeguards, and/or management measures to minimize the risk of 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 "Potential Impact Categories from Breach of

Embankment or Accidental Release" 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 under "Potential Impact Categories from Breach of Embankment or Accidental Release" may be significantly affected:

An auxiliary (emergency) spillway;

Additional freeboard;

Storage for wet year rather than normal year precipitation;

Reinforced embankment such as additional top width, flattened, and/or armored downstream side slopes;

Protection of exterior embankment slopes which may be exposed to erosive flow conditions when located on or near floodplains.

Secondary Containment.

The following options 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 the "Potential Impact Categories from Breach of Embankment or Accidental Release" may be significantly affected:

Outlet gate locks or locked gate housing;

Secondary containment;

Alarm system;

Another means to empty the required volume.

Potential Impact Categories from Breach of Embankment or Accidental Release

Surface waterbodies -- perennial streams, lakes, wetlands, and estuaries.

Critical habitat for threatened and endangered species.

Riparian areas.

Farmstead or other areas of habitation.

Off farm property.

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

Considerations for Minimizing the Potential of Waste Storage Pond Liner Failure

Sites with categories listed under "Potential Impact Categories for Liner Failure" should be avoided if possible. If avoidance is not possible, give consideration to providing an additional measure of safety from seepage.

Should any of the potential impact categories listed in “Potential Impact Categories for Liner Failure" be affected, consideration should be given to the following:

A clay liner designed in accordance with procedures in AWMFH, Chapter 10, Appendix 10D;

A flexible membrane liner over a clay liner;

A geosynthetic clay liner flexible membrane liner;

A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring liquid-tightness.

Potential Impact Categories for Liner Failure

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 solutionized bedrock such as limestone or gypsum.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor, other CPSs such as Anaerobic Digester, Ambient Temperature (365); Anaerobic Digester, Controlled Temperature (366); Waste Facility Cover (367); and Composting Facility (317), can be added to the waste management system.

Adjusting pH below seven may reduce ammonia emissions from the waste storage facility but may increase odor when waste is

surface applied (see CPS Waste Utilization, (633)).

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

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 purpose.

OPERATION AND MAINTENANCE

An O&M Plan shall be developed that is consistent with the purposes of the practice, its design life, safety requirements, and design criteria.

The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the SD NRCS CPS Nutrient Management (590). Include an explanation of permanent markers or recorders installed to indicate maximum operating level.

Include a strategy for removal and disposition of waste with least environmental damage during the normal storage period to the extent necessary to insure the pond's safe operation. This strategy includes removal of the contribution of unusual storm events that may cause the pond to fill to capacity prematurely with subsequent inflow prior to the end of the normal storage period.

Development of an emergency action plan should be considered for waste storage facilities 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.

Where evaporation facilities are included, the O&M Plan shall include specific language to explain that pumping (partial emptying) will be necessary to maintain required storage capacity during very wet weather. The O&M Plan should also address maintaining the moisture content of the bottom and inner side slopes of the facility during drought to reduce cracking and future seepage losses.

Remove all shrubs and woody vegetation. This includes shrubs and trees that are growing close enough to the waste storage facility to impact it with root growth.

REFERENCES

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