Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

CODE 313

(no)

DEFINITION

An agricultural waste storage impoundment or containment structure.

PURPOSE

This practice is used to accomplish one or more of the following purposes–

- Minimize or eliminate the impacts on surface water.
- Minimize or eliminate the impacts on groundwater resources.
- Minimize emissions such as greenhouse gases to improve air quality.

CONDITIONS WHERE PRACTICE APPLIES

Use where storage is needed for 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 with an embankment, this practice applies only to low hazard structures. A low hazard structure is defined as a dam in a rural or agricultural area where failure may damage farm building, agricultural land, or township and country roads (Title 210, National Engineering Manual (NEM), Part 520, Section 520.21,"Definition and Classes").

This practice does not apply to the storage of human waste or to a facility used exclusively for routine animal mortality. Use NRCS CPS Animal Mortality Facility (Code 316), for routine animal mortality.

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations

Plan, design, and construct the waste storage facility to meet all Federal, Tribal, State and local laws and regulations.

Location

Locate the waste storage facility outside the 100-year floodplain, unless site restrictions require locating it within the floodplain. Protect the facility from inundation from a 25-year flood event and structural damage from the 100-year flood event, if located within the floodplain. Additionally, follow the policy found in Title 190 General Manual, Ecological Sciences, Part 410, Subpart B, Section 410.25 Flood Plain Management, which may require additional protection, planning, or operating measures.

Foundation

Perform surface and subsurface investigations for all waste storage facilities sufficient in detail and analysis to support the design in accordance with Title 210, National Engineering Manual, Part -531,

"Geology" (210-NEM-531). Document the soil material encountered, the location of any seeps, the depth to water table, the depth to bedrock, the presence of sink holes, karst topography, the description and location to nearest water well(s), and other conditions that might affect the suitability of the site. Additional foundation criteria are listed specific to Criteria for Liquid Waste Storage Impoundments and Additional Criteria for Fabricated Structures.

Storage Period
The storage period is the maximum length of time anticipated between emptying events. Base the storage period on the timing required for environmentally safe utilization considering climate, crops, soils, and equipment.

Design Storage Volume
Size the facility to store the following volumes:

Operational Volume

- Manure, wastewater, bedding, and other wastes accumulated during the storage period.
- Include normal monthly precipitation less evaporation, where appropriate, during the storage period for liquid or slurry storage facilities.
- Normal runoff from the facility's drainage area during the storage period.
- Planned maximum residual solids. Provide a minimum of 6 inches for residual solids in tanks unless provisions that allow for complete emptying are included.
- Additional storage to meet management goals or regulatory requirements.

Emergency Volume (liquid storages only)

- 25-year, 24-hour precipitation on the surface of the liquid or slurry storage facility.
- 25-year, 24-hour runoff from the facility's drainage area.

Freeboard Volume (for liquid or slurry waste storage exposed to precipitation)

- Minimum of 6 inches for vertical walled facilities.
- Minimum of 12 inches for all other facilities and under-floor storages that require pit ventilation.

Freeboard is not required for roofed facilities that do not receive runoff unless required for ventilation.

Exclude non-polluted runoff from the structure where practical except where inclusion is advantageous to the operation of the facility.

Inlet Structures
Design inlet to resist corrosion, plugging, freeze damage, and ultraviolet deterioration. Design must incorporate erosion protection. For inlet structures, use NRCS CPS Waste Transfer (Code 634).

Waste Removal Components
Design components for removing waste such as gates, pipes, docks, wet wells, pumping platforms, retaining walls, or ramps in accordance with the applicable CPS, including but not limited to NRCS CPS Heavy Use Area (Code 561), Pumping Plant (Code 533) or Waste Transfer (Code 634). Account for all items that will influence the performance of the component including loading, durability, serviceability, material properties, and construction quality. Incorporate features to protect against erosion, tampering, and accidental release of stored waste. Design ramp slopes to accommodate anticipated equipment and traction. Components must be compatible with the land application methods specified in the nutrient management plan, NRCS CPS Nutrient Management (Code 590).

Accumulated Solids Removal
Preserve storage volume by including a provision for periodic removal of accumulated solids. Design the facility to accommodate the anticipated method of removing accumulated solids. This is important for determining the configuration of impoundments and the liner to be used.

Maximum Operating Level
The maximum operating level for liquid storage structures is the level that provides the operational volume.

Staff Gauge
Locate and specify the requirements for a staff gauge or other permanent marker in the liquid storage facility to clearly indicate the following elevations:

- Maximum operating level (top of the operational volume).
- Top of emergency volume.

Identify the method for the operator to measure the depth of accumulated waste in the Operation and Maintenance Plan, for facilities where the contents are not visible and a staff gauge would not be visible, such as below a slatted floor.

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

Provide appropriate warning signs, ladders, ropes bars, rails, and other safety devices. Include type, number, location, and details for installation of required safety features.

Use warning signs to identify the potential for explosion, poisoning, or asphyxiation.

Design covers and gratings over openings such that livestock or humans cannot accidentally displace them and fall into the facility. Design covers and gratings to handle expected operation loads.

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.

A fence is required around impoundments, excavated ponds, and uncovered tanks which have exposed walls less than 5 feet above the ground surface. Use NRCS CPS Fence (Code 382) to design a fence that will prevent accidental entry by people or animals. Post universal warning signs to prevent entry into liquid waste storage structures.

Roofs and Covers
Use NRCS CPS Roofs and Covers (Code 367) to design waste storage facility covers or roofs, as needed.

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

Additional Criteria for Liquid Waste Storage Impoundments

A liquid waste storage impoundment is a waste storage facility where the stored material does not consistently stack and is either a natural topographic depression, manmade excavation, or diked area formed primarily of earthen materials (although the facility may be lined with manmade materials).

Foundation
Locate the impoundment in soils with a permeability that meets all applicable regulations or line the impoundment with suitable material. Use liners which meet or exceed NRCS CPS Pond Sealing or Lining, Compacted Soil Treatment (Code 520), Pond Sealing or Lining, Geomembrane or Geosynthetic Clay Liner (Code 521), or Pond Sealing or Lining, Concrete (Code 522). Install an engineered pond liner or ensure foundation materials meet the maximum specific discharge rate as recommended by NRCS in AWMFH Appendix 10D or meets State or local regulations, whichever is more restrictive.

Include an evaluation in the liner design of all buoyant uplift forces on the liner for sites located in a floodplain or where there is potential for uplift. Limit projected uplift head under clay liners to a gradient of less than 0.5 ft/ft in the clay liner. The gradient is determined as the difference in total head between the top and the bottom of a clay liner when buoyant forces exist (such as when the floodplain is flooded) divided by the thickness of the clay liner.

Design Bottom Elevation
Locate the bottom elevation a minimum of 2 feet above the seasonal high-water table, to protect the integrity of the liner, 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.

Outlet
Do not use an outlet that can automatically release stored material except for septic tanks that feed a treatment system such as a vegetated treatement area or leaching field, or outlets leading to another storage facility with adequate capacity. Design a permanent outlet that will resist corrosion and plugging. Provide a backflow prevention measure for an outlet that pumps wastewater to secondary storage located at a higher elevation. This section does not apply to an auxiliary spillway.

Embankments
Design embankments to withstand loads associated with the waste storage structure. Increase embankment height by a minimum of 5% to allow for settling. Stabilize all embankments to prevent erosion or deterioration. Raise the embankment height where wave action may be a concern and protect the slope from wave action.

- Top width: Design minimum embankment top widths according to table 1.
- Side slopes: Design the combined side slopes of the settled embankment no steeper than 5-to-1. Design both side slopes no steeper than a 2-to-1 ratio, unless provisions are made for stability.
- Effective height: The difference between the bottom of the spillway crest (or the settled top of the embankment if there is no auxiliary spillway) and the lowest point on the existing ground along the embankment.
- Total embankment height is the difference between the settled top of the embankment and the lowest point on the existing ground along the embankment.

Table 1. Minimum Top Widths

Total embankment height (ft)	Top width, (ft)
Less than 15	8
15–19.9	10
20–24.9	12
25–34.9	14
35 or more	15

When effective height exceeds 20 feet, provide embankment protection by:

- Including an auxiliary spillway with the capacity to route the 25-year, 24-hour storm runoff from the facility drainage plus the 25-year, 24-hour precipitation volume on the surface of the liquid or slurry storage facility or a minimum of two feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment, whichever is greater.

- For embankments without an auxiliiary spillway raise the embankment above the design storage

volume an additional 25-year, 24-hour storm runoff from the facility drainage plus the 25-year, 24-hour precipitation volume on the surface of the liquid or slurry storage facility or one foot of freeboard whichever is greater.

Excavations

Specify excavated side slopes to meet the requirements of the type of liner selected, see NRCS CPS Pond Sealing or Lining, Compacted Soil Treatment (Code 520), Pond Sealing or Lining, Geomembrane or Geosynthetic Clay Liner (Code 521) or Pond Sealing or Lining, Concrete (Code 522).

Additional Criteria for Fabricated Structures

Foundation

Provide a foundation for fabricated waste storage structures to safely support all superimposed loads without excessive movement or settlement, based on the subsurface investigation (210-NEM-531).

Calculate settlement based upon site-specific soil test data, where a nonuniform foundation cannot be avoided or where applied loads may create highly variable foundation loads. Index tests of site soil may allow correlation with similar soils for which test data is available. Use presumptive bearing strength values for assessing actual bearing pressures obtained from table 2 or another nationally recognized building code when site-specific soil test data is not available. Provide adequate detailing and articulation to avoid distressing movements in the structure when using presumptive bearing values.

Table 2. Presumptive Allowable Foundation and Lateral Pressure[1]

Class of Materials	Vertical Foundation Pressure (psf)	Lateral Bearing Pressure (psf/ft below natural grade)	Coefficient of Friction[a]	Cohesion (psf)[b]
Crystalline bedrock	12,000	1,200	0.70	-
Sedimentary and foliated rock	4,000	400	0.35	-
Sandy gravel or gravel (GW and GP)	3,000	200	0.35	-
Sand, silty sand, clayey sand, silty gravel, clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	-
Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	-	130

Class of Materials	Vertical Foundation Pressure (psf)	Lateral Bearing Pressure (psf/ft below natural grade)	Coefficient of Friction[a]	Cohesion (psf)[b]
[1] International Building Code (IBC), 2018, International Code Council (ICC) [a] Coefficient to be multiplied by the dead load. [b] Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2 Lateral sliding resistance limit. For clay, sandy clay, silty clay, clayey silt, silt and sandy silt, the lateral sliding resistance shall not exceed one-half the dead load.				

For bedrock foundations, separate the floor slab and the bedrock by:

- A minimum of 2 feet of soil or,
- A liner that meets or exceeds NRCS CPS Pond Sealing or Lining, Compacted Soil Treatment (Code 520), Pond Sealing or Lining, Geomembrane or Geosynthetic Clay Liner (Code 521), or Pond Sealing or Lining, Concrete (Code 522) or,
- Other appropriate method or alternative that achieves equal protection.

Structural Loadings
Design the waste storage structure to withstand all anticipated loads in accordance with the requirements in Title 210, National Engineering Manual, Part 536, “Structural Design” (210-NEM-536), including, as applicable, internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, and water pressure due to seasonal high-water table, frost or ice.

Calculate loading from lateral earth pressures using soil strength values determined from the results of appropriate soil tests and procedures described in Technical Release 210-74, “Lateral Earth Pressures”. ASCE or ACI criteria may be used where appropriate. Table 3 provides minimum lateral earth pressure values when soil strength tests are not available. Use an additional soil surcharge or an additional internal lateral pressure in the wall analysis when equipment will operate near the wall.

Use a minimum internal lateral pressure of 65 lb/ft^2/ft of depth for stored waste that is not protected from precipitation. Use a minimum internal lateral pressure of 60 lb/ft^2/ft of depth for stored waste protected from precipitation and not likely to become saturated. Use a minimum internal lateral pressure of 72 lb/ft^2/ft of depth for sand-laden manure storage if the percentage of sand exceeds 20%. Designers may use lesser values if supported by measurement of actual pressures of the waste to be stored.

Table 3. Minimum Lateral Earth Pressure Values[1]

Description of Backfill Material [c]	Unified Soil Classification	Design Lateral Soil Load (lb/ft^2/ft of depth) [a]	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60

Description of Backfill Material [c]	Unified Soil Classification	Design Lateral Soil Load (lb/ft^2/ft of depth) [a]	
		Active pressure	At-rest pressure
Clayey gravels, poorly graded gravel-sand mixes	GC	45	60
Well-graded, clean sands; gravely sand mixes	SW	30	60
Poorly graded clean sands; sand-gravel mixes	SP	30	60
Silty sands,poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note [b]	Note [b]
Inorganic clayey silts, elastic silts	MH	Note [b]	Note [b]
Inorganic clays of high plasticity	CH	Note [b]	Note [b]
Organic clays and silty clays	OH	Note [b]	Note [b]

[1] Table 1610.1, Lateral Soil Load, International Building Code (IBC), 2018, International Code Council (ICC).

[a] Design loads based on moist conditions for the specified soils at optimum density. Actual field conditions shall govern. Submerged or saturated soil presures shall include the weight of the buoyant soil plus hydrostatic loads.

[b] Unsuitable as backfill material.

[c] The definition and classification of soil materials shall be in accordance with ASTM D2487.

Structural Design

Design structures with reinforced concrete, steel, wood, or masonry materials in accordance with 210-NEM-536, Structural Engineering. Account for all items that will influence the performance of the structure, including loading assumptions, durability, serviceability, material properties and construction quality. Ensure that the material used for a fabricated structure is compatible with the waste product to be stored.

Tanks may be designed with or without a cover. Design openings in a covered tank to accommodate equipment for loading, agitating, and emptying. Equip these openings with fencing, grills or secure covers for safety, and for odor and vector control as necessary.

Sensitive Environmental Settings
Classify and design the storage structure as a reinforced concrete hydraulic or environmental structure according to 210-NEM-536 where liquid-storage is to be provided in sensitive environmental settings (i.e., tanks in areas with shallow wells in surface aquifers, high-risk karst topography, or other site-specific concerns). Alternatively, use a flexible liner membrane, designed in accordance with standard engineering and industry practice, to provide secondary liquid containment for structures constructed with other methods described in 210-NEM-536.

Additional Criteria for Stacking Facilities
A stacking facility may be open, covered, or roofed and is used for wastes which behave primarily as solid. Determine the wall height using the anticipated stacking angle of repose of the waste material and any clearance height needed for containment of the stacked material. Construct a stacking facility of durable materials. Design the stacking facility with adequate safety factors to prevent failure due to internal or external pressures, including hydrostatic uplift pressure and imposed surface loads such as equipment which may be used within, on, or adjacent to the structure.

Seepage and Internal Drainage
Locate the stacking facility in soils with a permeability that meets all applicable regulations and use the appropriate NRCS CPS Pond Sealing or Lining, Compacted Soil Treatment (Code 520), Geomembrane or Geosynthetic Clay Liner (Code 521), or Concrete (Code 522) to reduce the potential for groundwater contamination.

Collect and utilize leachate in a safe manner to prevent pollution of surface or groundwater. Prevent influent seepage or surface runoff from infringing on the designed storage capacity or on the suitability of the waste being stacked and stored. Leachate control may not be needed on sites that have a roof, waste material with little seepage potential, or are located in arid climates.

Make provisions for drainage of leachate, including rainfall from the stacking area (especially those without a roof). Collect leachate and transfer to a tank, waste storage impoundment, treatment lagoon, or vegetated treatment area.

Poultry Litter Stacking Facility
For wood walled facilities, design the height of the litter stack not to exceed 7 feet, with litter to wood contact limited to 5 feet to reduce the potential for spontaneous combustion damage.

CONSIDERATIONS

General Considerations
Consider the use of textured liners or addition of features such as tire ladders, that would allow for escape from the waste storage structures, for exposed liners utilizing HDPE or similar materials that are slippery when wet.

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.

Consider environmental concerns, economics, the overall waste management system plan, and safety and health factors.

Provide the operator with the cost to close the facility since the economics and risks associated with waste storage facilities are quite high. Cost should include removal of the planned sludge accumulation volume and the waste stored at the maximum operating volume.

Considerations for Siting
Consider the following factors in selecting a site:

- Proximity to the source of waste.

- Access to other facilities.
- Ease of loading and unloading waste.
- Compatibility with the existing landforms, vegetation, and prevailing winds, including building arrangement to minimize odors and adverse impacts on visual resources.
- Adequate maneuvering space for operating, loading, and unloading equipment.
- Distance to surface water, wells, non-farm residence(s), and property lines.
- Avoid locating waste storage facilities upwind of areas where heavy gasses may accumulate.

Considerations for Minimizing Impacts of Sudden Breach of Embankment or Accidental Release from the Waste Storage

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:

- Downstream drinking water sources.
- 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.

Consider the following either individually or in combination to minimize the potential of or the consequences of sudden breach of embankments:

- An auxiliary spillway.
- Additional emergency volume.
- 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.
- Secondary containment.
- Dual liner.

Consider the following options to minimize the potential for accidental release from the waste storage facility through gravity outlets.

Comment on noting that electronic monitoring of water levels is available.

- Outlet gate locks or locked gate housing.
- Secondary containment.
- Addition of an electronic water elevation monitoring device or alarm system.
- Another non-gravity means of emptying the waste storage facility.

Considerations for Minimizing the Potential of Storage Pond 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.

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

Considerations for Stacking Facilities

Leachate collection within a stacking facility can be accomplished by use of a timber wall with the boards installed vertically, leaving 3/4-inch cracks. The timber wall drainage section may be included in a concrete or masonry block wall. Use the design criteria for timber walls.

Considerations for Organic Operations

Use rot-resistant or treated lumber that meets the requirements for organic production for any facility that is an organic producer or that sells manure to organic producers. The producer should consult with the organic certifier as to the use and acceptability of treated lumber for waste storage.

Considerations for Health and Safety

Consider the following options to minimize health and safety issues:

- Include adequate ventilation, especially when agitating stored manure.
- Add emergency equipment such as multi-gas monitor, buoys and self-contained breathing apparatus.
- Remove potential sources of sparks.
- Impacts of low berms around manure storage structures that can trap heavy gases and allow gases to collect above manure storages.

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. Solid manure storage may result in emissions of particulate matter, volatile organic compounds, ammonia, carbon dioxide, and nitrous oxide. Consider minimizing liquid storage time to reduce emissions.

Reduce emissions of greenhouse gases, ammonia, volatile organic compounds, particulate matter and odor, by adding other NRCS CPSs 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), and Air Filtration and Scrubbing (Code 371) to the waste management system.

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

Maintain appropriate manure moisture content for solid manure storage facilities. Excessive moisture will increase the potential for air emissions of volatile organic compounds, ammonia, and nitrous oxide, and may lead to anaerobic conditions, which will increase the potential for emissions of methane and hydrogen sulfide. Too little moisture will increase the potential for dust and other particulate matter emissions.

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 with relevant benchmark elevation and descriptions.
- Structural details of all components, including reinforcing steel, type of materials, and thickness.

- Locations, sizes, and type of pipelines and appurtenances.
- Requirements for foundation preparation and treatment.
- Backfill requirements: lift thickness, method of compaction, material type, material size and moisture content.
- Safety features.
- Material quantities.
- Approximate location of utilities and notification requirements.
- Vegetative requirements.

OPERATION AND MAINTENANCE

Develop an operation and maintenance 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 the following information where appropriate:

- Operational requirements for emptying the storage facility and the expected storage period. Begin removal of the liquid storage facility as soon as practical before the maximum operating level has been reached. Include the requirement that waste be removed from storage and utilized at locations, times, rates, and volume in accordance with NRCS CPS Nutrient Management (Code 590).
- Explanation of the staff gauge or other permanent marker to indicate the maximum operating level, for impoundments and other liquid storages. Identify the method for the operator to measure the depth of accumulated waste, for storages where the contents are not visible and a staff gauge would not be visible, such as below a slatted floor.
- Provisions for emergency removal and disposition of liquid waste in the event of an unusual storm event that may cause the waste storage structure to fill to capacity prematurely.
- Instructions, as needed, for ventilating confined spaces according to ASABE standard S607, Ventilating Manure Storages to Reduce Entry Risk.
- Develop an emergency action plan 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.
- Describe the routine maintenance needed for each component of the facility. Include provisions for maintenance that may be needed as a result of waste removal or material deterioration.

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