**Natural Resources Conservation Service**

**CONSERVATION PRACTICE STANDARD**

# WASTE STORAGE FACILITY

**Code 313**

**(No)**

## DEFINITION

An agricultural waste storage impoundment or containment made by constructing an embankment, excavating a pit or dugout, or by fabricating a structure.

## PURPOSE

To store manure, agricultural by-products, wastewater, and contaminated runoff to provide the agricultural operation management flexibility for waste utilization.

## CONDITIONS WHERE PRACTICE APPLIES

Use where regular 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 the NRCS Conservation Practice Standard (CPS) Waste Transfer (Code 634).

For liquid waste storage facilities implemented with an embankment, this practice applies only to low hazard structures as defined in the NRCS National Engineering Manual (NEM), Part 520.23.

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

## CRITERIA

**General Criteria Applicable to All Waste Storage Facilities.**

**Laws and Regulations**. Plan, design, and construct the waste storage facility to meet all Federal, State, and local laws and regulations. Waste storage facilities may need to be approved or permitted by the Kentucky Natural Resources and Environmental Protection Cabinet for Environmental Protection. Refer to KRS 224.10 (19).

**Location**. Locate and design the waste storage facility such that it is outside the 100-year floodplain unless site restrictions require locating it within the floodplain. If located in the floodplain, protect the facility from inundation or damage from a 25-year flood event. Additionally, follow the policy found in the NRCS General Manual (GM) 190, Part 410.25, Flood Plain Management, which may require providing additional protection for storage structures located within the floodplain.

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. Waste storage facilities shall be located as close to the source of waste and as far from neighboring dwellings or other areas of public use as practical. Waste storage facilities shall meet the minimum distance requirements from public or private facilities as shown in Table 1, unless a greater distance is required by state or local laws and regulations. Exception to these requirements may be granted where an existing animal feeding operation, which includes animals, housing, and structures, etc. is located and currently operating at a distance closer to one or more of the public or private use facilities shown in Table 1. Such existing operations will not be required to strictly comply with the minimum distance requirements providing the following requirements are met:

Moving the operation to comply with the Table 1 distance requirements is not practical from economic, topographic, or other site specific limitations.

2. A storage facility is needed and can be constructed, operated and maintained without pollution of surface or ground water resources.

3. The waste storage facility is to be planned, designed, and constructed to manage the waste generated from the current size operation only; it is not to provide for an increase to the current number of animals utilizing this sensitive site.

4. All permit requirements for the waste storage facility must be met.

**Table 1-Minimum Distance Requirements For Waste Storage Facilities Public or Private Use Facilities Minimum Distance From Waste Storage Facility**

| | |
|---|---|
| Churches, Schools, Businesses and public use areas | 1500 feet |
| Dwellings | 500 feet |
| Property Lines | 75 feet |
| Potable Water Wells | 300 feet |
| Natural Water Courses or Drainage Ditches | 150 feet |
| Federal and State Roads | 150 feet |
| County Roads | 100 feet |

**Storage Period**. The storage period is the maximum length of time anticipated between emptying events. Base the minimum storage period on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, State, and Federal regulations. . A storage period of 180 days is recommended for most liquid waste storage structures. The minimum storage period criteria for all structures shall be as indicated in Table 2.

**Table 2 – Minimum Storage Periods for Waste Storage Facilities**

| Days | Method of Disposal |
|---|---|
| 120 | Liquid or solid waste hauled |
| 90 | Liquid wastes pumped through irrigation delivery system |
| 7 | Milking parlor waste conveyed/w sprinkler irrigation and disposal area >200 feet from water conveyance |

**Design Storage Volume**. Size the facility to store the following as appropriate:

<u>Operational Volume</u>

- Manure, wastewater, bedding, and other wastes accumulated during the storage period.
- For liquid or slurry storage facilities, include normal precipitation (omit diverted roof runoff) less evaporation during the storage period.
- Normal runoff from the facility's drainage area during the storage period.
- Planned maximum residual solids. Provide a minimum of 6 inches for tanks unless a sump or other device allows for complete emptying.
- Additional storage when required 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 at the maximum level of the required design storage.
- 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" for vertical walled tanks.
- Minimum of 12" for all other facilities.

Exclude non-polluted runoff from the structure to the fullest extent practical except where including the runoff is advantageous to the operation of the agricultural waste management system. Domestic and industrial waste from wash down facilities, showers, toilets, sinks, etc. shall not be discharged into waste storage facilities.

**Inlet.** Design inlet to resist corrosion, plugging, freeze damage, and ultraviolet deterioration. Incorporate erosion protection as necessary. Inlets from enclosed buildings shall be provided with a water-sealed trap and vent or similar device to control gas entry into the buildings or other confined spaces.

Inlets may be pushoff ramps, paved slopes or pipe inlets.

Paved slopes shall be no flatter than 4 horizontal to 1 vertical (4:1) and will not be used when appreciable bedding materials are used.

Pipe inlets may be steel, concrete, aluminum, or PVC as required in NRCS conservation practice standard for

All pipes shall be designed to carry the required flow and shall be installed on a slope of 1 percent or greater and preferably 1.5 percent or greater. Where solids are being conveyed, the pipe diameter shall be sized to prevent plugging. Minimum pipe diameter will be 6 inches.

Pumped inlets shall be sized to meet the requirements of the pumping equipment. Gravity flow inlet pipes for liquid only may outlet at or above the design volume elevation. The slope of the pond at the pipe outlet shall be protected from erosion by paving or by extending the pipe outlet to a point where the discharge will not fall on the slope. Pipes shall be supported on pilings of pressure treated wood, steel, concrete, or masonry and anchored to prevent dislodging or flotation.

Large diameter gravity loading pipes for solids and liquids shall outlet at the bottom of the pond, and the effective head (vertical difference between the top of the drop inlet and the design volume elevations) shall be no less than 4 feet.

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

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

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

**Staff Gauge.** Place 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).
- Emergency level (top of the design storage volume).

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

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

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

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

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

Place a fence around impoundments and uncovered tanks which have exposed walls less than 5 feet above ground surface. Use the NRCS CPS Fence (Code 382) for design of a fence that will prevent accidental entry by people or animals likely to be onsite. Post universal warning signs to prevent children and others from entering liquid waste storage structures.

**Roofs and Covers.** Use NRCS CPS Roofs and Covers (Code 367) for design of 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 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, such as soil (although the unit may be lined with manmade materials) .

**Hazard Classification**. The area downstream of the embankment must be evaluated to determine the impact of damage from a sudden breach of the proposed embankment on both structural and environmental features. This evaluation must consider all improvements and those improvements that may reasonably be expected to be made during the useful life of the structure. The result of this examination provides for the proper hazard approval classification of the embankment. Only hazard class (a) embankments are to be designed under this standard. See National Engineering Manual Part 520.23 for guidance in documentation of hazard classification.

**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 (Codes 520, 521, or 522).

Perform subsurface investigations for all waste storage impoundments sufficient in detail and analysis to support the design in accordance with NRCS NEM, Part 531, Geology. Describe the soil material encountered, location of any seeps, depth-to-high-water table, depth to bedrock, and presence of sink holes in karst topography. Keep a minimum of 2 feet of soil between the finished bottom of the excavation and bedrock.

The investigation must evaluate soils to a depth no less than two feet below the final grade of any excavation. Deeper investigations may be required depending on site conditions. A determination as to whether a liner is needed will be based upon the site specific subsurface investigation and information on controlling seepage in AWMFH Chapter 7.

All earthen manure storage facilities shall be investigated by a qualified geologist and/or soil scientist and a written report prepared that addresses the water table depth, and potential for groundwater pollution considering the hydrology, groundwater gradient, soil permeability, etc. Considerations of findings in the geology / soils report shall be included in the design, construction, and operation plans for the specific site.

For the design of a liner on a site located in a floodplain and other locations where there is potential for uplift, include an evaluation of all potential buoyant uplift forces on the liner. 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 impoundment bottom elevation a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, impoundment seepage rate and non-encroachment of the water table by contaminants. The water table may be lowered by use of drains to meet this requirement.

**Outlet.** An outlet that can automatically release stored material is not permitted except for flouts in septic tanks that feed a treatment system such as a waste treatment strip 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 elevations.

**Embankments**. For an impoundment with greater than one acre of surface area and where wave action is a concern, increase the embankment height to account for calculated wave height. In all cases, increase the constructed embankment height by at least 5 percent to allow for settlement. Stabilize all embankments to prevent erosion or deterioration.

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

1. Layers of fill shall not exceed 9 inches in thickness before compaction. Compaction shall be accomplished by routing the hauling and spreading equipment over the fill in such a manner that every point on the surface will be traversed by not less than two tread tracks of the loaded equipment traveling in a direction parallel to the main axis of the fill.

2. Clayey soils shall be compacted with a “sheepsfoot” or tamping roller (See AWMFH Appendix 10D for guidance on compaction).

Minimum embankment top widths are shown in table 1. Design the combined side slopes of the settled embankment to be equal to or flatter than 5 horizontal to 1 vertical, with neither slope steeper than 2 horizontal to 1 vertical unless provisions are made for stability. The total embankment height (effective height) is the difference in elevation between the auxiliary (emergency) spillway crest or the settled top of the embankment if there is no auxiliary spillway and the lowest point in the cross section taken along the centerline of the embankment.

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

Table 3. Minimum Top Widths

| Total embankment height (ft) | Top width, (ft) |
|---|---|
| Less than 15 | 8 |
| 15–19.9 | 10 |
| 20–24.9 | 12 |
| 25–30 | 14 |
| 30–35 | 15 |

**Spillway or Equivalent Protection.** For a facility having a total embankment height greater than 20 feet, construct an auxiliary (emergency) spillway or route through the spillway or store below the spillway another volume equivalent to the emergency volume.

**Auxiliary Spillway. (For systems having a drainage area or watershed – add minimum size involved if needed.)** An auxiliary spillway, combination of spillways, or additional storage shall be provided to protect the waste storage pond from overtopping the embankment when a 25-year, 24-hour storm event is exceeded and the design volume is filled. The minimum width shall be 10 feet. The crest of the auxiliary spillway shall be located at or above the same elevation as the top of the 25-year, 24-hour storm storage. The auxiliary spillway shall be designed to pass a 25-year, 24-hour storm without overtopping the embankment. There shall be a minimum of 1foot of freeboard above the designed depth of flow in the auxiliary spillway. Auxiliary spillway requirements however do not apply to waste storage ponds without drainage areas and with less than 3 feet of storage above natural ground.

The auxiliary spillway shall be placed in undisturbed soil when possible. When it must be placed in fill material precautions shall be taken to insure the integrity of the structure. Where a waste storage pond empties into another waste storage pond and the liquid level is positively controlled by an adequately sized overflow pipe, no auxiliary spillway is required for the primary waste storage pond.

Pipe auxiliary spillways shall be 6 inch minimum diameter and meet the requirement in NRCS conservation practice standard for Pond, Code 378.

**Excavations.** Design excavated side slopes to meet the requirements of the liner used, see NRCS CPS Pond Sealing or Lining, Compacted Soil Treatment (Code 520), Pond Sealing or Lining, Flexible Membrane (Code 521a) or Pond Sealing or Lining, Concrete (Code 522).

**Liners.** The subgrade shall be dense base regardless of liner method. Liners shall be constructed at an elevation above the seasonal high water table unless methods to maintain the liner integrity are considered in the design. The storage pond shall be sealed by one of the liners as described below.

1. Compacted Earth. Earthen liners shall be designed in accordance with NRCS AWMFH Appendix 10D, Geotechnical Design, and Construction Guidelines to achieve a maximum allowable specific discharge of 0.0028 ft/day (1 x $10^{-6}$ cm/sec).

Compacted earth liners shall have a minimum thickness of 1 foot on pond sides and bottom measured perpendicular to the finished surface. The final liner thickness shall be determined using AWMFH Appendix 10D.

The liner shall be compacted the required density to ensure the maximum allowable specific discharge is not exceeded. Compaction requirements shall be verified in accordance with ASTM D – 698 or by methods approved by the engineer. Compacted earth liners shall have side slopes of 3 horizontal to 1 vertical (3:1) or flatter, except where compacted earth liners are part of (brought up with) an earthfill.

2. Flexible Membrane. Flexible membrane liners shall be designed and constructed in accordance with the NRCS conservation practice standard Pond Sealing or Lining–Flexible Membrane, Code 521A.

3. Bentonite. Bentonite liners shall be designed and constructed in accordance with the NRCS conservation practice standard Pond Sealing or Lining–Compacted Soil Treatment, Code 520.

4. Concrete. Concrete liners shall be designed and constructed in accordance with NRCS conservation practice standard Pond Sealing or Lining, Concrete, Code 522.

a. For side slopes and bottoms that will not have any vehicular traffic, use a minimum 4 inch thick concrete slab. No joints are required. Wire mesh or fiber reinforcement is required.

b. For concrete lined areas such as approaches, ramps, and bottoms that will have vehicular traffic of any kind, use a minimum 4 inch thick concrete slab placed over a minimum 4 inch thick layer of compacted gravel base. Joints and reinforcement shall be required by design analysis.

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

5. Natural Clay Base. Natural clay base liners shall have a minimum thickness as defined in NRCS AWMFH Appendix 10D. Minimum thickness shall be 1 foot. The soil shall meet the criteria for a unified soil classification of CL, CH, MH, SC, or GC. Natural clay liners shall have side slopes of 2 horizontal to 1 vertical (2:1) or flatter.

(see - earlier note of minimum thickness of undisturbed soil material over bedrock)

## Additional Criteria for Fabricated Structures

**Foundation.** Based on subsurface investigation, provide a foundation for fabricated waste storage structures to safely support all superimposed loads without excessive movement or settlement. Perform subsurface investigations for all fabricated structures sufficient in detail and analysis to support the design in accordance with NRCS NEM, Part 531, Geology. Describe the soil material encountered, location of any seeps, depth to high water table, depth to bedrock, and presence of sink holes in karst topography.

Where a nonuniform foundation cannot be avoided or where applied loads may create highly variable foundation loads, calculate settlement based upon 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 are available, use presumptive bearing strength values for assessing actual bearing pressures obtained from table 2 or another nationally recognized building code. In using presumptive bearing values, provide adequate detailing and articulation to avoid distressing movements in the structure.

For bedrock foundations with joints, fractures, or solution channels, separate the floor slab and the bedrock by—

- A minimum of 1 foot of soil.
- A liner that meets or exceeds NRCS CPS Pond Sealing or Lining (Codes 520, 521, or 522)).
- Other appropriate method or alternative that achieves equal protection.

Table 4. Presumptive Allowable Foundation and Lateral Pressure[1]

| Class of materials | Allowable foundation pressure (psf) | Lateral bearing (psf/ft) below natural grade | Coefficient of friction | Cohesion (psf) |
|---|---|---|---|---|
| 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 |

[1] International Building Code (IBC), 2015, International Code Council (ICC)

**Structural Loadings.** Design the waste storage structure to withstand all anticipated loads in accordance with the requirements in NRCS NEM, Part 536, Structural Design. Such loads should include 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. Table 3 provides minimum lateral earth pressure values when soil strength tests are not available. If heavy equipment will operate near the wall, use an additional soil surcharge or an additional internal lateral pressure in the wall analysis as appropriate.

For the lateral load from stored waste not protected from precipitation, use a minimum 65 lb/ft2/ft of depth as the design internal lateral pressure. Use a minimum value of 60 lb/ft2/ft of depth for the lateral load from stored waste protected from precipitation and not likely to become saturated. Use a minimum internal lateral pressure of 72 lb/ft2/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 5. Minimum Lateral Earth Pressure Values[1]

| Description of backfill material [c] | Unified soil classification | Design lateral soil load (lb/ft²/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 |
| Clayey gravels, poorly graded gravel-sand mixes | GC | 45 | 60 |
| Well-graded, clean sands; gravely sand mixes | SW | 30 | 60 |
| Sand-silt clay mix with plastic fines | 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 | CL-ML | 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), 2015, International Code Council (ICC).

[a] Design loads based on moist conditions for the specified soils at optimum density. Include the weight of the buoyant soil plus hydrostatic pressure for submerged or saturated soil.

[b] Unsuitable as backfill material.

[c] Base the definition and classification of soil in accordance with ASTM D 2487.

**Service Life and Durability.** Planning design, and construction shall ensure that the structure is sound and of durable materials commensurate with the anticipated service life, initial and replacement costs, maintenance and operation costs, and safety and environmental considerations.
Guidance in evaluating the service life of various materials is given in Table 6. The materials indicated meet the requirements of this standard. The service life of materials not shown shall be based on performance data.

**Table 6 – Service Life of Various Materials**

| Service Life | Material[1] |
|---|---|
| Short (Minimum of 15 years) | Wood; masonry, including concrete staves; flexible membranes; glass/fiber reinforced plastics/resins; steel coated with zinc, epoxy, vinyl and asphalt; reinforced concrete |
| Medium (minimum of 20 years) | Reinforced Concrete; glass fused steel |
| Long (minimum of 50 years) | Reinforced concrete; flexible membranes with earth covers |
| [1]The durability and estimated life of reinforced concrete is a function of the design and the quality of the concrete. A key aspect affecting durability is corrosion of the reinforcement which is directly related to cracking (design stress) and the reinforcement cover. The quality levels of reinforced concrete are discussed under "Structural Design". *** | |

**(*** Highly acid soil material and geology can shorten the life of wood, masonry, and concrete materials.)**

**Structural Design.** Design structures with reinforced concrete, steel, wood, or masonry materials in accordance with NRCS-NEM, Part 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.** 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), design the storage structure as a reinforced concrete hydraulic or environmental structure according to NRCS NEM, Part 536, Structural Design. Alternatively, use a flexible liner membrane, designed and constructed in accordance with standard engineering and industry practice, to provide secondary liquid containment for structures constructed with other methods described in NRCS NEM, Part 536, Structural Design.

**Additional Criteria for Holding Tanks**

Holding tanks are used for liquid and slurry waste and may be open or covered, within or outside of enclosed housing, or beneath slotted floors. Holding tanks shall be essentially watertight.

Depending on the hazard involved to the environment, tanks shall be constructed of reinforced masonry, coated or glass-fused steel or reinforced concrete. In-ground tanks shall have exterior drainage or a minimum safety factor of 1.3 against uplift, when empty.

Holding tanks shall be sufficiently watertight to retain liquids required for agitating and pumping and to function as planned. Effluent seepage in amounts that would pollute surface or ground water shall be prevented by watertight construction or collected and utilized in a safe manner. Influent seepage in amounts that would infringe on the designed holding capacity shall be prevented by watertight construction or site drainage.

Central loading from an elevation at or above the top of the sidewall of open holding tanks allows more complete and uniform filling, particularly with manure containing bedding. Steel and other corrodible materials shall be adequately protected with concrete, paint, or other protective coatings to prevent corrosion.
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 Structure Due to Use, and in ASAE EP393.2, Manure Storage, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon capacity shall be used.

All structures shall be underlain by free draining material.

A minimum of 6 inches of residual solids storage shall be provided for tanks.

**Additional Criteria - 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 the waste material. Construct a stacking facility of durable materials such as reinforced concrete, reinforced concrete block, or treated lumber. 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.

**Floor Slabs**. Concrete floors should normally slope away from the entrance toward the back of the storage area. The suggested design grade of the floors for beef and dairy manure stacking facilities is from 0.2 to 1.0 percent. Floors for poultry litter storage structures may be designed level.

**Timber Walls.** All post and lumber in contact with waste or exposed to moisture shall be pressure-treated in accordance with ASTM D 1760, "Standard Specification for Pressure Treatment of Timber Products."
Posts shall have a minimum size of 6 inch by 6 inch (nominal) and be placed in the ground from 3 to 6 feet deep, depending on the design analysis. Side planking shall be treated lumber with a minimum nominal thickness of 2 inches.

**Seepage.** Prevent leachate in amounts that would pollute surface or groundwater with collection and disposal of liquids in a safe manner as necessary. Prevent influent seepage in amounts that would infringe on designed storage capacity. Seepage control may not be necessary on sites that have a roof, waste material with little seepage potential or in certain climates.

**Internal Drainage.** Make provisions for drainage of leachate, including rainfall from the stacking area (especially those without a roof). Collect leachate in a tank or waste storage impoundment, or properly treat in a lagoon or vegetated treatment area.

**Poultry Litter Stacking Facility.** To reduce the potential for spontaneous combustion damage to wood walled facilities, design the height of the litter stack not to exceed 7 feet, with litter to wood contact limited to 4 feet.

## CONSIDERATIONS

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

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

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

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

**Considerations for Siting**

Consider the following factors in selecting a site for waste storage facilities:

- Proximity of the waste storage facility to the source of waste.
- Access to other facilities.
- Ease of loading and unloading waste.
- Compatibility with the existing landforms and vegetation, including building arrangement, to minimize odors and adverse impacts on visual resources.
- Adequate maneuvering space for operating, loading, and unloading equipment.

**Considerations for Solids Separation**

To minimize frequency of solids removal from waste storage ponds, route polluted runoff through vegetative filter strips, low-gradient channels, or debris basins to remove readily settleable solids. Settling facilities should have adequate capacity to store settled solids for a time period based on climate, equipment, clean out frequency, and method of disposal. If animal manure, such as from dairy cows, is flushed into a storage pond, a solids separator may be provided for removing fibrous solids to facilitate pumping and irrigation. Solid separators, debris basins, etc., shall be designed with appropriate liners to prevent seepage to the groundwater.

**Considerations for Water Quantity**

Waste storage facilities will have an affect on the water budget. The affect will be dependent upon the size of the waste storage facility. The waste storage facility will cause an increase in evaporation and a decrease in downstream runoff where drainage is designed to the facility. The waste storage facility will not increase water demand at the site.

**Considerations for Water Quality**

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

**Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Waste Storage Facility.**

Consider 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 when any of the categories listed below might be significantly affected.

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

- Surface water bodies—perennial streams, lakes, wetlands, and estuaries.
- Critical habitat for threatened and endangered species.
- Riparian areas.
- Farmstead, or other areas of habitation.
- Off-farm property

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

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

- 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.
- Secondary containment.
- Double liners.

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

- Outlet gate locks or locked gate housing.
- Secondary containment.
- Alarm system.
- Another nongravity means of emptying the waste storage facility.

**Considerations for Minimizing the Potential of Waste 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.

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

**Considerations for Stacking Facilities**
Internal seepage 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.

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

**Considerations for Improving Air Quality**
An anaerobic lagoon instead of a waste storage pond should be considered for sites located in rural areas where odors are a concern. This should be especially considered where odors would affect neighboring farms having enterprises that do not cause odors and/or neighbors who earn a living off-farm. The recommended loading rate for anaerobic lagoons at sites where odors must be minimized is one-half the values given in AWMFH Figure 10-22.

For sites located near urban areas practices such as the following should be considered to reduce odor emissions:

1. Covering the storage facility with a suitable cover.

2. Using naturally aerated or mechanically aerated lagoons.

3. Using composting in conjunction with a solid waste system rather than a liquid or slurry system.

4. Using a methane digester and capture system.

## PLANS AND SPECIFICATIONS

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

- Plan view of system layout.
- Structural details of all components, including reinforcing steel, type of materials, thickness, anchorage requirements, lift thickness.
- Locations, sizes, and type of pipelines and appurtenances.
- Requirements for foundation and preparation and treatment.
- Vegetative requirements.
- Quantities.
- Approximate location of utilities and notification requirements.
- Drainage/Grading plan as needed.
- Soil, geology, and foundation findings, interpretations, and reports.

## 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 where appropriate:

Include the operational requirements for emptying the storage facility including the expected storage period. Begin removal of the liquid storage facility as soon as practical after the maximum operating level has been reached. Also include the requirement that waste be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan.

For impoundments and other liquid storages include an explanation of the staff gauge or other permanent marker to indicate the maximum operating level. For storages where the contents are not visible and a staff gauge would not be visible, such as below a slatted floor, identify the method for the operator to measure the depth of accumulated waste.

Include a provision 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.

Include instructions as needed for ventilating confined spaces according to ASABE standard S607, Venting 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.

Include a description of the routine maintenance needed for each component of the facility. Also include provisions for maintenance that may be needed as a result of waste removal or material deterioration.

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