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

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

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

CONDITIONS WHERE PRACTICE APPLIES

The storage and/or settling facility is a component of a conservation plan and Comprehensive Nutrient Management Plan (CNMP) and shall be compatible with other components of the conservation plan and CNMP.

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 waste treatment, refer to CPS Waste Treatment Lagoon (Code 359) and Waste Treatment (629).

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 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, State, and local laws and regulations. Additional criteria may apply for installations requiring a State of Ohio Permit to Install (PTI) or National Pollution Discharge Elimination System (NPDES) permit.

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. If the 25-year frequency flood elevation is not readily known, it shall be based on the best information available or by determining the water elevation associated with the 25-year frequency, 24-hour duration rainfall 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.

Table 1- Ohio Specific Siting Requirements Based on Ohio Administrative Code 901: 10-2-02

SOURCE WATER		FABRICATED STRUCTURE **1/**	MANURE STORAGE POND OR TREATMENT LAGOON **1/**
WELLS	Public Water Well (At least 15 Service Connections or serves an average of 25 people for at least 60 days each year)	At least 300 ft.	
	Community Water System (at least 15 Service Connections used by year-round residents or serves at least 25 year-round residents)	Not within the 1-yr time of travel or at least 1,000 ft., whichever is greater	
	Non-Community Water System (a public water system that is not a community water system)	Not within the 1-yr time of travel or at least 300 ft. if time of travel is not designated	
	Private Water Supply Well (controlled by the owner of the facility to be installed)	50 ft.	300 ft.; may be reduced to 100 ft. with engineered controls
	Private Water Supply Well (not controlled by the owner of the facility to be installed)	At least 300 ft.	
	Highly Susceptible Well	Not within 1-yr to 5-yr time of travel	
SURFACE WATER INTAKE		Beyond the Emergency Management (EM) Zone (designated by the Source Water Assessment and Protection Program) or At least 1,500 ft. if EM Zone has not been designated	
COLD WATER HABITAT AND SEASONAL SALMONID STREAMS		300 ft.	600 ft.
AQUIFER	Natural lined pond	At least 15 ft. of low permeability material between waste and aquifer	
	Earthen, Synthetic, or Concrete Liner	At least 5 ft. of low permeability material	
SOLE SOURCE AQUIFERS		Ground water monitoring or engineered controls or both	
FLOODPLAINS		Embankments or wall must be designed to withstand hydrostatic pressures from a 100-yr flood AND elevation to top shall be 100-yr flood plus 2 ft.	
FLOODWAYS		Shall not be located in established regulatory floodway as defined by FEMA	

KARST AREAS	Shall not be located in karst area without engineered controls
BEDROCK	At least 3 ft. of low permeability material between bottom of waste and bedrock
MINES	Shall not be located in area of potential subsidence due to underground mine without engineered controls
PROPERTY LINES OR PUBLIC ROADS	No closer than 100 ft. Can be closer to neighbor's property line with written agreement
1/ Siting requirements may be reduced by using additional design criteria (engineered controls approved by the Ohio NRCS State Conservation Engineer) and/or groundwater monitoring.	

Locate a facility a minimum of 300 ft. from a neighboring residence unless a written waiver between the parties allows something less than 300 ft. If a gas well is located within a 100 ft. radius of the facility, evaluate the situation and mitigate the risk of possible groundwater contamination.

Biological Hazard
Evaluate the impact of a sudden breach, liner failure or accidental release for potential water contamination and biological hazard to humans. Section 651.0204 of the Agricultural Waste Management Field Handbook (AWMFH) is to be used as a guide for the evaluation. Decisions regarding the evaluation are to be documented in the design file.

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.

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

Operational Volume

- 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 except that rainfall less evaporation shall not be less than zero for any month during the design period. Evaporation can be ignored to yield a more conservative design.
- 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.
- The design inputs used to size the facility must be documented by one (or both) of the following:
    - The current NRCS animal waste management design software using the latest data source or hand calculations referencing manure volumes from the current edition of NRCS National Engineering Handbook (NEH) Part 651, Agricultural Waste Management Field Handbook, Chapter 4, and rainfall/ runoff volumes from the NRCS Engineering Field Handbook (EFH) Chapter 2
    - Actual records in place of published NRCS data, when available.

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.

No freeboard is required for roofed facilities that do not receive runoff. 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.

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

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. Entrance or exit ramps shall have a slope of 10 horizontal to 1 vertical or flatter. 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).
- The ½ and ¾ maximum operating volume level elevations (at the producer’s option)

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 to both animals and humans (refer to the American Society of Agricultural and Biological Engineers (ASABE) Standard EP470.1-Manure Storage Safety for guidance as needed).

Provide safety stops, gates, 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 animals 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 buildings or other 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 humans or animals likely to be onsite. Post universal warning signs to prevent children and others from entering liquid waste storage structures.

Locate the permanent fence so that easy access is possible for the agitating and pumping equipment.

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 associated fasteners and connectors.

Service, Life, and Durability
Plan, design, and construct storage and settling facilities to provide a minimum service life of 10 years.

Erosion Protection
Vegetate embankments and all disturbed areas surrounding facilities to control erosion. Refer to NRCS Ohio Conservation Practice Standard 342- Critical Area Planting.

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).

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). Use a synthetic liner with leak detection where the DRASTIC >160 AND there is < 15 ft of low permeability material between the bottom of waste placement and the top of the aquifer or the top of bedrock that is also an aquifer. A clay liner is inclusive of the 15 ft.

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. Guidance on logging foundation conditions is given in AWMFH, Chapter 7, Geology and Groundwater Considerations. 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. Explore at least five feet below the planned bottom of a proposed manure storage pond and at least three feet below the bottom of a planned fabricated structure.

Where available, use the Ohio Department of Natural Resources (ODNR), Division of Water Resources, Ground Water Pollution Potential (DRASTIC) Maps to estimate the pollution potential for each site. Areas having a pollution potential index above 160 indicate a high potential to pollute groundwater.

A geological exploration is required for sites:

- Within a high pollution potential area (DRASTIC >160 and/or <15 feet of low permeability material between waste placement and the top of uppermost aquifer). Lab analysis is also required in this instance.
- Within an EPA designated sole source aquifer boundary
- Requiring a permit to install from the Ohio Department of Agriculture (ODA) Livestock Environmental Permitting Program

- Requiring data to determine the amount of an additive for reducing specific discharge/permeability

The geological exploration will be completed by an engineering geologist or someone under the technical supervision of an engineering geologist. Laboratory testing may need to be performed prior to design.

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. See Table 1 for requirements with regards to bedrock and aquifers.

Drains and Drainage
Existing subsurface drainage lines that are within 50 ft. of the edge of the maximum operating level of the impoundment shall be removed and/or relocated. However, an adjacent surface water diversion system may have subsurface drain lines no closer than 25 ft. to the edge of the maximum operating level surface.

Where permanent or seasonal high water tables are anticipated, include a perimeter drain to collect the water and relieve the uplift pressure. These drains are typically used in conjunction with a liner (refer to Lining Waste Storage Ponds or Settling Facilities section below). The perimeter drain may fully encircle the pond or may only be installed on the side(s) where the elevated water table is anticipated. Locate the drain as far from the inside toe of the slope as possible. Regardless of the location, the drain shall be installed with a down slope inspection port for future monitoring. The inspection port shall be a capped watertight riser pipe with a minimum diameter of 8 in. The top of the riser pipe shall be elevated a minimum of 12 in. above the ground surface and located a minimum of 50 ft. from the edge of the storage pond where it will not be subjected to damage. Refer to Appendix 10D in the Agricultural Waste Management Field Handbook (NEH Part 651) for additional design guidelines.

Outlets
An outlet that can automatically release stored material is not permitted except for 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 elevation.

A gravity pipe, when used to empty a storage pond, shall be equipped with two valves to prevent an accidental release. One valve is to be located near the pipe inlet below the frost line and the other is to be located near the pipe outlet. Each valve shall have an independent power source and be dual acting (able to apply pressure to flow in either direction).

Design Volume for Settling Ponds as a Component of a Treatment System
Design settling ponds for treatment systems for a minimum 6 months manure production from the animals plus any solid by- products entering the storage or treatment system. The transfer pipe invert elevation will be set at the maximum design volume.

Emabankments
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.

Minimum embankment top widths are shown in Table 2. Increase the top width to a minimum of 12 ft for embankments traversed by farm equipment. Use a minimum 20-ft top width for agitation and pump-out areas. Design the side slopes of the settled embankment to be no steeper than 3 horizontal to 1 vertical. 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.

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

Soil Compaction
Minimum compaction requirements for soils used for embankments and for sealing the pond bottom as necessary when special liners are not required are as shown in the Ohio Construction Specification "Earthfill".

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.

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- Geomembrane or Geosynthetic Clay Liner (Code 521), or Pond Sealing or Lining- Concrete (Code 522).

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. See Table 1 for setback restrictions and considerations with regards to floodplains and floodways.

Additional Criteria for Fabricated Structures

Fabricated Structure Design
Fabricated manure storage structures shall meet the design criteria in this standard. Fabricated manure storage structures designed under this standard are categorized into one of two criterion as shown below.

- Manure Tight Concrete – The design of these structures shall follow the requirements set forth in the current document Ohio NRCS Design and Construction Specification- Concrete. Examples of manure tight concrete structures are heavy use area (HUA) pads; manure scraping and storage access aprons (slabs); dry stack and slurry manure storage structures; and manure storage tanks. These structures are designed as concrete slabs (floors) and/or sidewalls.
    - Manure storage tanks shall meet the requirements of Section 4 "Concrete Manure Storage Tanks" in the Ohio NRCS Design and Construction Specification- Concrete. The walls and the floor slab shall be liquid tight. A structure is considered to be liquid tight when all liquids are contained within the structure. Joint sealing and the use of waterstops are required for liquid tight structures. The Type S-3 Slab (as described in the same specification) shall be used as the floor slab. The minimum floor slab thickness is 5.5 inches and shall contain distributed reinforcing steel. Limit the use of control joints to achieve the most liquid tight slab possible. Table 1 "Type S-3 Slab Requirements" in the Ohio Concrete Specification has selections for slabs that will allow no control joints to be required in the slab. Waterstops shall be used in the walls at all joints.
    - Slabs used for manure scraping, storage access aprons, dry stack or slurry manure storage facilities can be either a Type S-1 or Type S-2 concrete slab as appropriate for the foundation conditions and/or vehicular traffic condition. Foundation and vehicular traffic conditions for Types S-1 and S-2 concrete slabs are described in the current Ohio NRCS Design and Construction Specification- Concrete.
    - Slabs used for sand lanes and adjacent sand dewatering pads can be either Type S-2 or Type

S-3 concrete slabs as appropriate for the foundation condition and/or vehicular traffic condition. Waterstops shall be used between these slabs and walls that are used in conjunction with them. Control joints shall be used as specified for the type of slab. Waterstops shall be used in all construction joints (if they are used).

- Pen Pack (or composting bedded pack) – These are permanently covered facilities where livestock are housed. The manure builds up in the housing area to a design depth and is periodically removed. The facility is managed in such a way that the solids content of the manure is high enough that it will not flow.

The sides of pen pack facilities are to be designed as manure tight and may be constructed of concrete or wood post and plank (refer to Ohio standard drawing OH-N-531 for post and plank wall details). Floors may be concrete or aggregate. When DRASTIC is >160 or there is less than 15 ft of low permeability material between the bottom of the waste and the top of the uppermost aquifer, the floor must be concrete. When DRASTIC >160 and there is less than 15 ft of low permeability material between the bottom of the waste and the top of the uppermost aquifer or bedrock that is an aquifer, the pen pack floor must be dowelled Type 2 slab concrete with sealed control joints.

Concrete floors shall be designed to meet the requirement of either a Type S-1 or Type S-2 slab as described in the Ohio NRCS Design and Construction Specification- Concrete. Practice Standard 561 – Heavy Use Area Protection shall be used to design aggregate floors for pen pack manure storage facilities when both the following conditions exist:

- The pad is minimally disturbed by tire spinning, loader gouging, and turning of loading equipment during manure removal. This generally means access is straight in and out.
- Manure is removed from the facility three times each year or less.

Pen pack manure storage facilities are to be designed with a manure storage height of 24 inches to 30 inches. The floor area is the minimum of:

- The corresponding area necessary to meet the storage volume interval documented in the CNMP or grazing management plan, or
- Livestock stocking density recommendations from Midwest Plan Service, livestock industry publications, or from written recommendations from an experienced livestock housing specialist working as a consultant to the producer. The following stocking densities may be used in lieu of specific recommendations:

Species/Type	Avg Weight (lb)	Surface Function	Stocking Density (ft2/head)
Feeder Cattle - Calf	600	Paved Floor in Barn Without Lot	25
Feeder Cattle - Finishing	1000	Paved Floor in Barn Without Lot	35
Bred Heifer	800	Paved Floor in Barn Without Lot	35
Beef Cow	1000	Paved Floor in Barn Without Lot	40
Beef Cow	1300	Paved Floor in Barn Without Lot	50
Composting Dairy facility	Use recommendations from “Evaluating the Effectiveness of Dairy Bedded Pack Systems in Ohio” OSU Extension (11-1-2010-revised) or “Kentucky Compost-Bedded Pack Barn Project”, University of Kentucky, April 2013		

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. An engineering geologist shall perform all investigations for fabricated structures that will be constructed in sensitive environments, such as a DRASTIC > 160, the presence of a sole source aquifer, or the proposed site is within the 1-yr or 5-yr travel time of a highly susceptible well. The investigation should extend at least three feet below the proposed bottom of the structure. ODA permited facilities shall follow the recommendations of the geotechnical report. 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.

To eliminate potential uplift pressures, install a drainage system entirely around the foundation that can be discharged via a gravity outlet or a sump pump.

Where a non-uniform 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 3 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 where the rock contains an aquifer, separate the floor slab and the bedrock or aquifer by:

- A minimum of 3 feet of compacted low permeability material.
- 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 3. Presumptive Allowable Foundation and Lateral Pressure1

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]Interanational 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 4 provides minimum lateral earth pressure values when soil strength tests are not available. If heavy equipment will be operated within 5 feet of a wall, the wall design shall include an additional 100 psf horizontal surcharge load.

For the lateral load from stored waste not protected from precipitation, use a minimum 65 lb/ft^2/ft of depth as the design internal lateral pressure. Use a minimum value of 60 lb/ft^2/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/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, e.g., the lateral pressure from poultry manure may be less than 60 lbs/ft2/ft. Document the value used. Roofed facilities designed to store dry materials such as sawdust bedded horse stable manure or well managed livestock mortality compost may be designed using a lateral pressure of 35 lbs/ft^2/ft of depth.

Tank covers shall be designed to withstand both dead and live loads. Use the minimum live load values for covers contained in ANSI/ASAE EP378.4 “Floor and Suspended Loads on Agricultural Structures Due to Use” and in ANSI/ASAE EP393.3 “Manure Storages”. Use the actual axle load for tank wagons having more than a 2,000 gallon capacity.

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.

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.

The minimum design and material quality requirements for fabricated structures are as follows:

- **Steel**- American Institute of Steel Construction *Manual of Steel Construction* for the design of steel beams and columns, etc.
- **Timber**- American Wood Council *National Design Specification for Wood Construction*

  Timber shown on the construction drawings that is specified to meet certain quality standards must be delivered to the site with the appropriate grade stamp that was stamped on the timber at the mill. Grading information for Southern Yellow Pine is available from the Southern Pine Inspection Bureau at the following web site: http://www.spib.org/grademarks.shtml?/lumberservices

  Engineered timber products (such as glue laminated timber, laminated veneer lumber (LVL), and nail laminated timber) are to be grade stamped or the manufacturer must provide documentation upon product delivery showing that the material properties conform to the structural requirements shown on the drawings.

- **Treated Wood**- (refer to NRCS CPS Roofs and Covers Code 367)

  Timber used as permanent foundation members, such as posts, shall meet AWPA, Use Category UC4B (ground contact, heavy duty). Typical concentration levels meeting UC4B are 0.6 lbs/cubic foot of MCQ, CCA or ACQ; 0.31 lbs/cubic foot of CA-B; and 0.23 lbs/cubic foot µCA-C.

  Timber or lumber exposed to weather or manure contact shall meet AWPA, use category UC4A (ground contact, general use). Typical concentration levels meeting UC4A are: 0.4 lbs/cubic foot of CCA or ACQ; 0.34 lbs/cubic foot of MCQ; 0.21 lbs/cubic foot of CA-B, and 0.14 lbs/cubic foot µCA-C.

  Galvanized connectors and fasteners as specified above may be used on CCA treated wood for AWPA UC4A and UC4B applications.

- **Reinforced Concrete**- American Concrete Institute (ACI) *Building Code Requirements for Structural Concrete, ACI 318* and Ohio NRCS Design and Construction Specification- Concrete (210-VI-EFH, Exhibit OH17-1, current edition). The minimum compressive strength for concrete is 4,000 psi. For concrete with reinforcing steel, meet all local electric codes dealing with Concrete Embedded Elements, Equipotential Planes, and Voltage Gradients.
- **Masonry Concrete**- American Concrete Institute (ACI) *Building Code Requirements for Masonry Structures, ACI 530*
- **Precast Concrete**- National Precast Concrete Association *Guide Specification for Plant-Precast Concrete Products*

  Precasters shall be certified by the National Precast Concrete Association's Plant Certification Program or meet the quality control standards as described in the guide specification. The precast supplier must provide certification that delivered products conform to the guide specification.

  A listing of certified producers and suppliers can be found on the NPCA's web site: http://precast.org/publications/

Sensitive Environmental Settings
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 sitespecific 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 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.

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 5 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.

Install concrete pads on the bottom of the pond to protect it from erosion during agitation. Use a minimum size of 15 ft. by 15 ft. area and 5 inches thick. Steel reinforcement is not required. Space the pads around the perimeter of the pond at a distance of twice the agitation radius or according to the agitator manufacturer's recommendation.

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 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 non-gravity 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 (karst) such as limestone or gypsum.
- A DRASTIC rating of 160 or greater

See Table 1 for specific requirements with regards to aquifers, karst, or shallow bedrock. 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

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.

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, particulate matter and odor, other NRCS CPSs such as Anaerobic Digester (Code 366), Roofs and Covers (Code 367), Waste

Treatment (Code 629), Amendments for Treatment of Agricultural Waste (Code 591), Composting Facility (Code 317), and Air Filtration and Scrubbing (Code 371) can be added to the waste management system.

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

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

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 particulate matter emissions.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended use. Construction drawings provided by others shall be stamped by a Professional Engineer or Registered Architect and certified to meet this standard.

Requirements for all drawings prepared by NRCS/SWCD as well as by others (Professional Engineer or Registered Architect) are contained in the National Engineering Manual (NEM) Part 541- Drafting and Drawings. Additionally, all Waste Storage Facility engineering plans and specifications shall include at a minimum the following:

- Plan view of system layout.
- Structural details of all components, including reinforcing steel, types of materials, thickness, anchorage requirements, lift thickness.
- Locations, sizes, and types of pipelines and appurtenances.
- Profiles for manure transfer/ irrigation pipelines.
- Requirements for foundation and preparation and treatment.
- Quality specifications for materials as applicable such as strength and preservative requirements for timber and fasteners; type, thickness and material properties of flexible membrane cover; Ohio NRCS concrete specification; and pipelines used for manure transfer.
- References and quality standards for components supplied by others.
- Special safety requirements (fence, safety barricades, etc.).
- Special surface water diversion considerations.
- Seeding, fertilizing, and mulching requirements.
- Well location if within the proximity of the site.
- Proximity of the facility to livestock housing and applicable manure transfer structures.
- Reference to roof runoff structure when applicable.
- Location and details of heavy use area pad when applicable.
- Quantities and bill of materials.
- Roofing details (Fabricated Structure)
- Reference to roof runoff structure details when applicable (Fabricated Structure)
- For Holding Ponds and Lagoons with embankments, the requirements are the same as for a Pond
- Clay and/or Synthetic Liner requirements (Earthen Structure)

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. Use the appropriate Ohio O&M template (NEM OH511.8) to create the O&M plan for a waste storage facility.

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 in the 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, 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.

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.

REFERENCES

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

Ohio Administrative Code 901:10-1-02 Definitions. http://codes.ohio.gov/oac/901:10-1-01

Ohio Administrative Code 901:10-2-02 Permit to install: siting criteria. http://codes.ohio.gov/oac/901:10-2-02

USDA Natural Resources Conservation Service. 1992. Agricultural Waste Management Field Handbook. USDA-NRCS, Washington, DC.

National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook, Ohio Issue 1 Chapter 7, Geology and Groundwater Considerations, June, 2005
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/oh/technical/engineering/?cid=nrcs144p2_029538

USDA Natural Resources Conservation Service. General Manual. USDA-NRCS, Washington, DC.

USDA Natural Resources Conservation Service. National Engineering Manual. USDA-NRCS, Washington, DC.

USDA Soil Conservation Service. 1989. Technical Release Number 74, Lateral Earth Pressures, USDA-SCS, Washington, DC.

ACI 318- Building Code Requirements for Structural Concrete ACI 360R- Guide to Design of Slabs-on-Ground

ANSI/ASAE EP378.4- Floor and Suspended Loads on Agricultural Structures Due to Use ANSI/ASAE EP379.5- Management of Manure Odors

ANSI/ASAE EP393.3- Manure Storages

ANSI/ASAE EP486.2- Shallow Post and Pier Foundation Design

MidWest Plan Service. 1993. Livestock Waste Facilities Handbook, MWPS-18, all chapters. Iowa State University, Ames, IA

DRASTIC Maps for selected counties are available from ODNR; information about the maps is available by calling (614) 265-6740, or on-line at: http://water.ohiodnr.gov/maps/pollution-potential-maps

Water well logs from ODNR, Division of Water, can be located on-line at: http://water.ohiodnr.gov/search-file-well-logs

County Ground Water Resource maps are available from ODNR, information on map is available by calling (614) 265-6740, or on-line at:

http://water.ohiodnr.gov/maps/groundwater-resources-maps

Information about Ohio EPA's Source Water Assessment and Protection Program (SWAP) and Sole Source Aquifers is available at:

http://www.epa.state.oh.us/ddagw/swap.aspx

NRCS Drawing and Design Reference Web Sites:

Agricultural Waste Management Field Handbook and Animal Waste Management (AWM) design program:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/oh/technical/engineering/?cid=nrcs144p2_029573

Ohio NRCS Standard engineering drawings:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/oh/technical/engineering/?cid=nrcs144p2_029558

Ohio conservation practice standards (e-FOTG):
http://www.nrcs.usda.gov/wps/portal/nrcs/main/oh/technical/

Ohio NRCS Design and Construction Specification- Concrete:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/oh/technical/?cid=nrcs144p2_029577

Ohio technical references- general link:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/oh/technical/engineering/?cid=nrcs144p2_029542

GLOSSARY

Aquifer – [(OAC 901:10-1-01 (K)] an underground consolidated or unconsolidated geologic formation or series of formations that are hydraulically connected and that have the capability to receive, store, and yield usable quantities of water to wells. Aquifer does not include perched groundwater.

Community Water System – [OAC 901:10-1-01] A community water system is one that serves at least fifteen service connections used by year-round residents or regularly serves at least twenty-five year-round residents.

Highly Susceptible Well– [OAC 3745-9-01] Susceptibility is the likelihood for the source of water used by a public water system to become contaminated, as determined through the source water assessment and protection program (Ohio EPA's program based on the Safe Drinking Water Act (SDWA)).

Karst Terrain – [OAC 901:10-1-01 (SS)] Karst terrain means an area where karst topography, including the characteristic surface and subterranean features, has developed as the result of dissolution of limestone, dolomite or other soluble rock. Characteristic physiographic features present in karst terrains may include the following:

1. Sinkholes

2. Sinking streams
3. Caves and caverns

Manure – [ORC 903.01 (O)] "Manure" means any of the following wastes used in or resulting from the production of agricultural animals or direct agricultural products such as milk or eggs: animal excreta, discarded products, bedding, process waste water, process generated waste water, waste feed, silage drainage, and compost products resulting from mortality composting or the composting of animal excreta.

Low Permeable Material – Permeability refers to the rate at which water flows through a material. Low permeability materials generally have 20 percent or more passing a No. 200 sieve and have a PI of 16 or greater; also refer to NEH Part 651 "Agricultural Waste Management Field Handbook", Chapter 7, Fig. 7-11 "Permeability of Various Geologic Materials".

Non-community Water System –[OAC 910:1-01(WWW) (2)] A non-community water system is one that does not service at least fifteen service connections used by year round residents or regularly serves at least twenty-five year-round residents.

Non-Transient, Non-Community Water System– [OAC 910:1-01(WWW) (2)(a)] A Non-Transient, Non-Community water system is a Public Water System that is not a Community Water System and that regularly serves at least twenty-five of the same persons over six months of the year.

Public Water System– [OAC 910:1-01(WWW)] A well with at least 15 service connections, or that serves an average of 25 people on a daily basis for at least 60 days per year.

Sole Source Aquifer– (US- EPA) The aquifer supplies at least 50% of the drinking water for its service area; there are no reasonably available alternative drinking water sources should the aquifer become contaminated.

Transient Non-Community Water System – [OAC 910:1-01(WWW) (2)](b)]This is a non-community public water system that does not regularly serve at least twenty-five of the same persons over six months of the year.