NATURAL RESOURCES CONSERVATION SERVICE

VIRGINIA CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(No.)

CODE 313

DEFINITION

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

PURPOSE

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

CONDITIONS WHERE PRACTICE APPLIES

- Where the storage facility is a component of a planned agricultural waste management system
- Where temporary storage is needed for organic wastes generated by agricultural production or processing
- Where the storage facility can be constructed, operated and maintained without polluting air or water resources
- Where site conditions are suitable for construction of the facility
- To facilities utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.
- To fabricated structures including tanks, stacking facilities, and pond appurtenances.

CRITERIA

General Criteria Applicable to All Waste Storage Facilities.

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

Location. To minimize the potential for contamination of streams, waste storage facilities shall be located outside of the 100-year floodplains unless otherwise allowed by state law. Refer to Virginia Design Note 2 – Separation Distances for Animal Waste Facilities for minimum separation distances.

Waste storage facilities shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Storage Period. The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be 120 days or the storage needed to utilize waste in accordance with a current certified Nutrient Management Plan.

Design Storage Volume. The design storage volume equal to the required storage volume, shall consist of the total of the following as appropriate:

(a) Manure, wastewater, and other wastes accumulated during the storage period.

(b) Normal precipitation less evaporation on the surface area (at the design storage volume level) of the facility during the storage period.

(c) Normal runoff from the facility's drainage area during the storage period.

(d) 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility.

(e) 25-year, 24-hour runoff from the facility's drainage area.

(f) Residual solids after liquids have been removed. A minimum of 6 inches shall be provided for tanks.

(g) Additional storage as may be required to meet management goals or regulatory requirements.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage and ultraviolet ray deterioration while incorporating erosion protection as necessary.

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

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

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock.

Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines shall be provided with a water-sealed trap and vent, or similar device, if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose.

Erosion Protection. Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Water Table. The seasonal high water table shall be determined either by long-term monitoring or by the presence of diagnostic soil redoximorphic features as identified during on-site investigations conducted by an individual trained in soil and water relationships. For the purpose of this standard, “seasonal high water table” refers to the upper limit of soil saturation with water during the wettest season, and can occur at any depth within the entire soil profile observed during an on-site soils investigation. The NRCS Field Book for Describing and Sampling Soils recognizes three types of seasonal high water tables: apparent, perched, and artesian.

If feasible, the seasonal high water table may be lowered by the use of an artificial drainage system. The drainage system shall be designed by a qualified individual.

Subsurface Investigations. A subsurface investigation is required for all waste storage facilities. Subsurface investigations shall be conducted by individuals trained in soil science, engineering, geology, or a related field.

The number and depth of test holes, pits, or borings will vary depending on the planned surface area and depth of the structure and the conditions encountered during the investigation such as the complexity of the soils, the depth to groundwater, and the presence or absence of seeps. At a minimum, there shall be one test hole, pit, or boring for each 5,000 ft^2 for the first 20,000 ft^2 of planned storage facility surface area plus at least one test hole, pit, or boring for each additional 10,000 ft^2. Each test hole, pit, or boring shall extend at least 2 feet below the planned bottom of the structure. The

log for each test hole, pit, or boring shall indicate the following:

- Existing ground surface elevation;
- A description of the soil material encountered using the Unified Soil Classification System;
- Depth to changes in the soil material encountered;
- Depth to any seeps encountered;
- Depth to high water (note method of determination: mottling, free water encountered, etc.); and
- Depth to bottom of test hole, pit, or boring.

The location and log information for all test holes, pits, and/or borings in or near the structure shall be shown on the construction drawings.

Depending on site conditions, the use of Ground Penetrating Radar, seismographs, or similar equipment may be necessary to complete the site investigation.

Additional Criteria for Waste Storage Ponds

Hazard Classification. The area downstream of the embankment must be evaluated carefully to determine the impact a sudden breach of the proposed embankment would have on structural and environmental features and to public safety. This evaluation must consider all improvements that may reasonably be expected to be made during the useful life of the structure. The results of this examination provides for the proper hazard approval classification of the embankment. See National Engineering Manual (NEM) Part 520.21 for guidance concerning documentation of hazard class determination.

Soil and foundation. The pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the pond shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The pond shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless features of special design are incorporated that address buoyant forces, pond seepage rate and non-encroachment of the water table by contaminants.

Maximum Operating Level. The maximum operating level for waste storage ponds shall be the pond level that provides for the required volume less the volume contribution of precipitation and runoff from the 25-year, 24-hour storm event plus the volume allowance for residual solids after liquids have been removed. A permanent marker or recorder shall be installed at this maximum operating level to indicate when drawdown should begin. The marker or recorder shall be referenced and explained in the O&M plan

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

Waste Pond Lining. Uncompacted self-sealing linings from native soil are not acceptable for waste containment. **All waste ponds shall be sealed or lined to achieve a permeability of 1 x 10^{-6} cm/sec (0.0028 feet/day) or less on all interior impoundment surfaces**. The liner subgrade shall be a dense base regardless of liner method. Liners shall be protected from punctures caused by adjacent fill materials and waste pond filling and pumping operations.

Soil liners should be avoided in karst areas. If soil liners are used in a karst area, a geologic site investigation shall be done to determine the potential for onsite sinkholes to develop. If a high risk is determined by the geologist or other qualified individual, a flexible membrane or concrete liner shall be used.

The construction of piers, loading ramps, inlets, outlets, and other appurtenances must be accomplished in a manner that does not damage or impair the operation of the liner system. The construction area must be free of water.

The waste pond shall be sealed by one of the following methods:

1. Compacted Soil Liners

A compacted soil liner consisting of a compacted soil dispersant mixture will be

designed and constructed in accordance with Virginia Conservation Practice Standard *Pond Sealing or Lining, Soil Dispersant Treatment (Code 521B)*.

A bentonite liner will be designed and constructed in accordance with Virginia Conservation Practice Standard *Pond Sealing or Lining, Bentonite Treatment (Code 521C)*.

A compacted clay liner will be designed and constructed in accordance with Virginia Conservation Practice Standard *Pond Sealing or Lining, Compacted Clay Treatment (Code 521 D)*.

2. Flexible Membrane

A flexible membrane liner will be designed and constructed in accordance with Virginia Conservation Practice Standard *Pond Sealing or Lining, Flexible Membrane (Code 521A)*.

3. Concrete Liner

A reinforced concrete liner may be used. The liner should be designed in accordance with slabs-on-grade criteria for fabricated structures requiring watertightness.

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the waste storage pond's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

Table 1 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

Additional Criteria for Fabricated Structures

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

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 2 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Foundations consisting of bedrock with joints, fractures, or solution channels shall be treated or a separation distance provided consisting of a minimum of 1 foot of impermeable soil between the floor slab and the bedrock or an alternative that will achieve equal protection.

Table 2 - Presumptive Allowable Bearing Stress Values[1]

Foundation Description	Allowable Stress
Crystalline Bedrock	12,000 psf
Sedimentary Rock	6,000 psf
Sandy Gravel or Gravel	5,000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3,000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2,000 psf

[1] Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)

Design Storage Volume. One foot of freeboard shall be added above the design storage volume for all structures that store liquid manure. There are no freeboard requirements for solid stacking fabricated

structures. Solid stacking implies that the manure has a consistency that does not flow, but stays in place even during the wettest time of storage period. The design volume for solid stacking fabricated structures may exceed the height of the structure walls. The anticipated stacking angle of the manure must be considered in determining the required wall height.

Liquid Tightness. Applications such as tanks, that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry practice appropriate for the construction materials used to achieve this objective.

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

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 3 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the following conditions:

- **Rigid frame or restrained wall.** Use the values shown in Table 3 under the column "Frame tanks," which gives pressures comparable to the at-rest condition.
- **Flexible or yielding wall.** Use the values shown in Table 3 under the column "Free-standing walls," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

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

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

Roofs and Covers. Design waste storage facility covers and roofs to meet the requirements of the conservation practice standard in Virginia NRCS Conservation Practice Standard *Roofs and Covers (Code 367)*.

Roof designs shall be certified by a Virginia professional engineer (P.E.). If the facility is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

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

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

TABLE 3 - LATERAL EARTH PRESSURE VALUES[1]

Soil		Equivalent fluid pressure (lb/ft^2/ft of depth)			
		Above seasonal high water table[2]		Below seasonal high water table[3]	
Description[4]	Unified Classification[4]	Free-standing walls	Frame tanks	Free-standing walls	Frame tanks
Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[5]	GP, GW, SP, SW	30	50	80	90
Gravel, sand, silt and clay mixtures (less than 50% fines) Coarse sands with silt and and/or clay (less than 50% fines)	All gravel sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35	60	80	100
Low-plasticity silts and clays with some sand and/or gravel (50% or more fines) Fine sands with silt and/or clay (less than 50% fines)	CL, ML, CL-ML SC, SM, SC-SM	45	75	90	105
Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65	85	95	110
High plasticity silts and clays (liquid limit more than 50)[6]	CH, MH	-	-	-	-

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

All structures shall be underlain by free draining material or shall have a footing located below the anticipated frost depth. Fabricated structures shall be designed according to the criteria in the following references as appropriate:

- Steel: "Manual of Steel Construction", American Institute of Steel Construction.
- Timber: "National Design Specifications for Wood Construction", American Forest and Paper Association.
- Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318", American Concrete Institute.
- Masonry: "Building Code Requirements for Masonry Structures, ACI 530", American Concrete Institute.

Treated Wood. When exposed to waste or elements, use preservative-treated wood that meets the requirements in the applicable American Wood Protection Association (AWPA) Standards or in an evaluation service report prepared by an organization recognized by the International Code Council (ICC). All fasteners, connectors, and any other metal contacting treated wood shall meet the requirements of the wood preservative manufacturer.

Slabs on Grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Where applied point loads are minimal and liquid-tightness is not required, such as barnyard and feedlot slabs subject only to precipitation, and the subgrade is uniform and dense, the minimum slab thickness shall be 5 inches with a maximum joint spacing of 10 feet. Joint spacing can be increased if steel reinforcing is added based on subgrade drag theory.

For applications where liquid-tightness is required such as floor slabs of storage tanks, the minimum thickness for uniform foundations shall be 5 inches and shall contain distributed reinforcing steel. The required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, “Design of Slabs-on-Grade”.

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

CONSIDERATIONS

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

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

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

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

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

Features, safeguards, and/or management measures to minimize the risk of failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 4 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 4 may be significantly affected:

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

Table 4 - Potential Impact Categories from Breach of Embankment or Accidental Release

1. Surface water bodies -- perennial streams, lakes, wetlands, and estuaries
2. Critical habitat for threatened and endangered species.
3. Riparian areas
4. Farmstead, or other areas of habitation
5. Off-farm property
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 4 may be significantly affected:

1. Outlet gate locks or locked gate housing
2. Secondary containment
3. Alarm system
4. Another means of emptying the required volume

Considerations for Minimizing the Potential of Waste Storage Pond Liner Failure.

Sites with categories listed in Table 5 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from pond seepage when any of the potential impact categories listed in Table 5 may be significantly affected.

Should any of the potential impact categories listed in Table 5 be affected, consideration should be given to the following:

1. A clay liner designed in accordance with procedures of AWMFH Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1 x 10^{-6} cm/sec
2. A flexible membrane liner over a clay liner
3. A geosynthetic clay liner (GCL)
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness

Table 5 - Potential Impact Categories for Liner Failure

1. Any underlying aquifer is at a shallow depth and not confined
2. The vadose zone is rock
3. The aquifer is a domestic water supply or ecologically vital water supply
4. The site is located in an area of solutionized bedrock such as limestone or gypsum.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor, other practices such as *Anaerobic Digester (Code 366)*, *Waste Facility Cover (Code 367)*, and *Composting Facility (Code 317)* 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.

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

Considerations for Preventing Spontaneous Combustion

Certain types of dry wastes, such as poultry litter, are susceptible to spontaneous combustion. To minimize this potential, poultry litter in a stacking facility should have less than 40 percent moisture, and dry litter and moist litter should not be layered. In addition, the height of the litter stack shall not exceed 7 feet, with litter-to-wood contact limited to 3 feet.

Considerations for Preventing Explosions in Waste Tanks

If foaming is observed in a waste storage tank, proper precautions should be taken to avoid release of highly concentrated noxious or explosive gases. Open flames and other

possible ignition sources should be extinguished or removed from confined or indoor spaces. Extreme caution is required during agitation and pumping of waste when manure foaming is present.

PLANS AND SPECIFICATIONS

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

Record all required information in an engineer field book, on a plan sheet or design computation sheet, or in another appropriate location.

DESIGN DATA

1. Completed Environmental Evaluation and subsequent requirements.
2. Soils investigation.
3. Survey and plot data: profile, cross-sections, topography, as needed.
4. Design computations, including purpose of practice and references used.
   a. Waste volume and sizing calculations.
   b. Structural Calculations (as necessary).
   c. Drainage Calculations (as necessary).
5. Plan view of site with existing and planned features, including dimensions, distances, etc.
6. Standard Cover Sheet (VA-SO-100A).
7. Materials and quantities needed. Identify borrow material and/or spoil area, as needed.
8. Vegetation and/or ground cover requirements.
9. Identification of needed Erosion & Sediment Control measures.
10. Supplemental practices required.
11. Virginia Conservation Practice Specifications (700 Series).
12. Operation and Maintenance Plan.
13. A completed Agricultural Waste Management System Plan for the owner's total livestock operation that addresses types and numbers of animals, including an Emergency Action Plan.

CHECK DATA

1. As-built survey.
2. As-built plans including dimensions, types and quantities of materials installed, and variations from design. Include justification for variations.
3. Locations of appurtenant practices.
4. Adequacy of vegetation and/or ground cover.
5. Complete as-built section of Cover Sheet.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

The plan shall contain the operational requirements for emptying the storage facility. This shall include the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan.

In addition, for ponds, the plan shall include an explanation of the permanent marker or recorder installed to indicate the maximum operating level.

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

An emergency action plan will be prepared for all waste storage facilities. This plan is a part of the Agricultural Waste Management System Plan.

REFERENCES

1. USDA-Natural Resources Conservation Service. Electronic Field Office Technical Guide (eFOTG), Section IV [Online]. Available at http://www.nrcs.usda.gov/technical/eFOTG

2. USDA-Natural Resources Conservation Service. National Engineering Manual.
3. USDA-Natural Resources Conservation Service. National Engineering Handbook – Part 650, Engineering Field Handbook.
4. USDA-Natural Resources Conservation Service. Agricultural Waste Management Field Handbook.
5. USDA-Natural Resources Conservation Service. Technical Release 74 (TR-74), Lateral Earth Pressures.
6. USDA-Natural Resources Conservation Service. Field Handbook for Describing and Sampling Soils.
7. ASCS/SEI-7, Minimum Design Loads for Buildings and Other Structures.
8. American Institute of Steel Construction, Manual of Steel Construction.
9. American Forest and Paper Association, National Design Specifications for Wood Construction.
10. American Concrete Institute, ACI-318, Building Code Requirements for Reinforced Concrete.
11. American Concrete Institute, ACI-360, Design of Slabs on Grade.
12. American Concrete Institute, ACI-530, Building Code Requirements for Masonry Structures.