

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

WASTE STORAGE FACILITY

(Each)

CODE 313

DEFINITION

A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout pond, 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 [Comprehensive Nutrient Management Plan \(CNMP\)](#).
- 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 Applying to All Facilities

Laws and Regulations. Waste storage facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations. [These include Vermont Accepted Agricultural Practice and Large Farm Operation Regulations.](#)

Comprehensive Nutrient Management Plan. [A fully developed Comprehensive Nutrient Management Plan shall accompany the waste storage facility design.](#)

Location. To minimize the potential for contamination of streams, waste storage facilities should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. 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. [The manure storage facility shall be located a minimum of 300 feet up gradient \(horizontal distance\) and/or 100 feet down gradient from all wells, springs and other potable water sources. The distance to neighboring wells shall be 500 feet regardless of grade. These distances shall be greater in environmentally sensitive locations such as well head protection areas.](#)

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Storage Period. The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and local, state, and federal regulations. The minimum storage duration shall be no less than 180 days. However, a longer storage period up to 365 days is recommended and shall be compatible to the manure application schedule in the nutrient management plan.

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

- (a) Manure, bedding, 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 and other structures, and 18 inches for manure ponds, unless provisions are made to remove the residual solids and an annual basis.
- (g) Additional storage as may be required to meet management goals or regulatory requirement.
- (h) Freeboard for structures shall be 6 inches. Freeboard for ponds or combination pond and structure shall be 12 inches.
- (i) For stacking pads and facilities with picket dams and/or perforated risers, freeboard and storage of precipitation and runoff may be eliminated, provided adequate provisions are made to store or treat the runoff and wastewater.

Picket Dams and Perforated Risers. Picket dams and perforated risers may be used on uncovered manure stacking facilities for draining rain water, snow melt and liquid manure. The drainage water shall be collected and directed to a storage or treatment facility. Picket dams shall be designed in accordance to the Vermont Design Procedure for Timber Walls (Carlson Method). The openings between pickets shall be between 3/4 inch to 1 inch.

Perforated risers shall be located out of the way, braced or protected from damage by unloading equipment or manure loads. Riser openings shall be 1/2 inch to 1-inch holes or slots randomly spaced around the full height of the riser. Screens may be installed with perforated risers to reduce plugging of perforations. Picket dams and perforated risers may be used together.

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. Inlets, such as gravity pipes and pumps shall be designed in accordance to practice code 634 - "Manure Transfer".

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.

Ramps used to gain access to the facility shall be 7 horizontal to 1 vertical or flatter. For facility where constant traffic in and out is anticipated a ramp that is 10 horizontal to 1 vertical or flatter is recommended. All access ramp surfaces shall be roughened to provide better traction.

Sumps that are two feet lower than the design bottom should be installed to allow more thorough clean-out of the facility.

Anti-Scour Pad. Anti-scour devices or pads shall be installed at all anticipated pump out and agitation locations to prevent erosion to the foundation, embankment and/or lining of the pond.

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 2 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. **Warning signs shall also be posted at all reception pits, hoppers and any other confined area that may contain harmful gases.** 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. **A minimum of four warning signs, including one at each access point shall be installed on all facilities. Fencing around waste storage facility shall be:**

1. Woven Wire (6 inch grid) with a single strand of barbed wire above,
2. Five strand barbed wire,
3. Six strand high tensile, or
4. Chain Link.

No other fencing style or configuration will be allowed with out the State Conservation Engineer's permission. Fencing, gates and other appurtenances shall be designed in accordance to standard code 382 - Fence. All fences installed around manure storage facilities shall be a minimum of 48 inches high from the ground to the top of the wire. All fences installed around waste storage facilities

with synthetic liners shall be 60 inches high with the appropriate number of additional strands of wire. Above ground glass lined tanks, such as Slurry Store facilities, do not need to be fenced provided all other safety precautions are made.

Erosion Protection. Measures shall be taken during construction to minimize site erosion and pollution of downstream water resources. This may include such items as silt fences, hay bale barriers, temporary vegetation, and mulching. Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Additional Criteria for Waste Storage Ponds

Soil and Foundation. The waste storage pond shall be located in soils with an acceptable permeability that meets all applicable regulation, or the waste storage pond shall be lined. Information and guidance on controlling seepage from waste impoundment's can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D. **All soil material shall be laboratory tested to determine the soil classification, which may include atterberg limits. All soil liners shall be designed accordance to Appendix 10D of the AWMFH, unless a SEEPAGE analysis and other documentation shows minimal threat to the ground water in accordance to the flow chart on page 7-23 of the AWMFH.**

The waste storage 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. The water table may be lowered by use of perimeter drains, if feasible, to meet this requirement. **Waste storage ponds shall have a bottom elevation that is a minimum of 2 feet above bedrock regardless of lining type. Blasting of bedrock should only be considered for structure and synthetic lined facilities. Blasting of bedrock within 300 feet of a waste storage facility must have the State Conservation Engineer's approval.**

Flexible membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in NRCS

Practice Standard 521A, Pond Sealing or Lining, Flexible Membrane Lining.

Soil Liners. All waste storage ponds constructed in soils that do not meet the requirements outlined in Appendix 10D of the AWMFH shall have a liner installed on the bottom and side slopes. In situ or borrow soils may be used to construct a soil liner provided:

- (a) The earth lined manure storage flow chart on page 7-23 of the AWMFH shall be used to determine the need for soil liner, synthetic liner, a structure or other alternative.
- (b) Soil linings are designed in accordance to Appendix 10D of the Agricultural Waste Management Field Handbook (AWMFH). Minimum soil liner thickness shall be 12 inches.
- (c) Detailed geologic analysis may provide other recommendations. This investigation must be extended at least three feet below the anticipated bottom elevation of the storage pond and be performed by a geologist or trained personnel with the proper approval authority.
- (d) Soil linings shall be placed on slopes that are 3:1 or flatter.
- (e) For those ponds which are partially or entirely excavated below natural grade, spoil material should be placed beyond the top of the cut slope so as not to endanger the stability of the slope.

Concrete Linings. Concrete may be installed as a liner material provided:

- (a) The concrete extends up the side slopes to top of embankment elevation.
- (b) The concrete shall be class 3000 or better.
- (c) The concrete slab shall be at least five inches thick with steel reinforcement suspended in the middle of the slab.
- (d) Reinforcing steel shall be #4 bars at 18 inches on center.
- (e) All cold joints shall be sealed with an approved waterstop. Saw cut control joints are not required.
- (f) The location of bedrock is greater than 2 feet below finished grade.

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. Gravity outlets are not generally recommended.

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 10 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 Values¹

Foundation Description	Allowable Stress
Crystalline Bedrock	12000 psf
Sedimentary Rock	6000 psf
Sandy Gravel or Gravel	5000 psf
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3000 psf
Clay, Sandy Clay, Silty Clay, Clayey Silt	2000 psf
¹ Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)	

Liquid Tightness. Applications such as tanks, that require liquid tightness shall be designed and constructed in accordance with standard engineering and industry 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 (NEH Part 633). 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/ft³ where the stored waste is not protected from precipitation. A value of 60 lb/ft³ may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored. If heavy equipment will be operated near the wall, an additional two feet of soil surcharge shall be considered in the wall analysis.

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

If the facility is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads. 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.

TABLE 3 - LATERAL EARTH PRESSURE VALUES¹

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.

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

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

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

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 4 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". **Unless otherwise designed, the reinforcing steel in the floor slab shall be #4 rebar at 18 inches on center. No control joint will be required unless a lighter steel schedule is designed. Fiber mesh reinforcement may NEVER be substituted for steel reinforcement.**

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.

A seepage analysis may be performed on all potential waste storage facilities, including stacking facilities, using Geologic Tech. Note N5 - "SEEPAGE: A System for Early Evaluation of the Pollution Potential of Agricultural Groundwater Environments" or other approved method.

Neighboring relationships should be considered when developing a waste storage facility or field stacking plan or design.

This practice may adversely affect cultural resources. Planning, installation and maintenance must comply with GM 420, Part 401.

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 6 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 6 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 6 - Potential Impact Categories from Breach of Embankment or Accidental Release

<ol style="list-style-type: none"> 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.
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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 6 may be significantly affected:

- 1.

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 7 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 7 may be significantly affected.

Table 7 - Potential Impact Categories for Liner Failure

<ol style="list-style-type: none"> 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.
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Should any of the potential impact categories listed in Table 7 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 1×10^{-6} cm/sec
2. A flexible membrane liner over a clay liner
3. A geosynthetic clay liner (GCL) flexible membrane liner
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness.

Considerations for minimizing the impact of odors.

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

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.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for the Waste Storage Facility and any other associated conservation practices. Maintenance needs are to be discussed with the landowner or operator who is responsible for maintaining the practices installed with NRCS assistance. Any hazards must be brought to the attention of the responsible person. Prior to construction, sufficient copies of the O&M plan shall be provided to the owner/operator, designer, and approving agencies. The owner shall sign the O&M plan to indicate an understanding of the requirements and a commitment to operate and maintain the area as specified.

An operation and maintenance (O&M) 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 O&M plan shall also be consistent with Standard 590 - Nutrient Management.](#)

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 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. Development of an emergency action plan should be considered for waste storage facilities where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.