SOIL CONSERVATION SERVICE

WASTE STORAGE STRUCTURE

Definition

A fabricated structure for temporary storage of animal wastes or other organic agricultural wastes.

Scope

This standard establishes the minimum acceptable requirements for planning, designing, constructing, and operating and maintaining waste storage structures, including waste storage tanks and waste stacking facilities. It does not apply to waste storage ponds (425) or to waste treatment lagoons (359), even though they may have paved ramps or linings. Storage tanks are used for liquid and slurry wastes and may be: (1) Open or covered, (2) within or outside an enclosed housing, or (3) beneath slotted floors. Stacking facilities are used for wastes that behave as a solid and may be open or roofed.

Purpose

To temporarily store liquid or solid wastes as part of a pollution-control or energy-utilization system to conserve nutrients and energy and to protect the environment.

Conditions Where Practice Applies

This practice applies where: (1) The structure is a component of an overall plan prepared according to SCS standard for waste management systems (312); (2) temporary storage is needed for organic wastes generated by agricultural production or processing; (3) the structure can be located without polluting air or water resources; and (4) soils and topography are suitable for construction of the structure.

Planning Considerations

General. This practice shall not be installed until an overall waste management system (312) has been considered and the essential components determined.

All federal, state, and local laws, rules and regulations governing waste management, pollution abatement, health, and safety shall be strictly adhered to. The owner or operator shall be responsible for securing all required permits and approvals and for performing in accordance with such laws and regulations. Regulations published by the Environmental Protection Agency are listed on page WI-1-1 of the Agricultural Waste Management Field Manual. Responsibility for enforcement of the EPA regulations in Wisconsin is under the authority of the Department of Natural Resources.

Location. The following factors must be considered in selecting a site for waste storage structures: Proximity of the structure to the source of wastes, access to other facilities, ease of loading and emptying wastes, appropriate health regulations, and direction of prevailing winds to minimize odors.

Reception pits and hoppers from which manure is pumped to storage facilities must be: (1) Located at least 75 feet from the nearest well or reservoir; (2) be liquid tight; and (3) have floors which are at least 3 feet above bedrock and/or highest ground water level.

The minimum distance from any well or reservoir to a manure storage structure shall be 100 feet for the following structures:

1. Temporary manure stacks or storage platforms which have a liquid-tight concrete floor on grade or partially on grade used to store solid manure. Solid manure contains sufficient bedding to absorb most of the liquids from animals, contains no milking center liquids or runoff from barnyards, and will retain a sloped shape when stacked or piled.

2. Liquid-tight reinforced concrete or lined steel holding tanks (or equivalent structure).

Other waste storage structures must meet the location distances to wells or reservoirs as stated in the standards for waste storage ponds (425).

All waste storage structures must have floors which are three feet or more above bedrock or highest ground water level. Variances from this vertical separation requirement will be considered if other design alternatives are included which compensate for the reduced distance. Requests for such variances will be submitted to the state conservation engineer (when the design is prepared by SCS offices).

Soil and foundation. Soil profiles obtained by borings or backhoe test pits shall be made to an elevation at least three feet below the anticipated floor elevation of the storage structure. Normally a distance of five feet or more is desirable unless bedrock is reached above this depth.

Environmental protection. All disturbed land surfaces shall be vegetated or otherwise stabilized to control soil erosion. The location, layout, and design of the facilities should be compatible with the surrounding landscape. Existing landforms and vegetation, along with land shaping and vegetative plantings, shall be considered to minimize an adverse impact upon visual resources.

Facilities must be constructed in areas and in a manner which prevents flooding.

Loading and unloading. Adequate maneuvering space shall be provided for operating loading and unloading equipment. Pushoffs must be structurally sound and must be provided with railings, safety bars, or other devices to prevent humans, animals, and equipment from falling into the facility. Provisions shall be made for removing liquids that accumulate from solid wastes or from precipitation.

Disposal facilities. Equipment shall be available for removing wastes from the storage structure, processing them for energy, or applying them to the land at the locations, times, and rates shown in the overall management plan.

Service life and durability. Planning, design, and construction shall insure that the structure is sound and of durable materials commensurate with the anticipated service life, initial and replacement costs, maintenance and operation costs, and safety and environmental considerations.

Guidance in evaluating the service life of various materials is given below. The materials indicated meet the requirements of this standard. The service life of materials not shown shall be based on performance data.

Service life	Material[1/]
Short (minimum of 10 yr)	Wood; masonry, including concrete staves; flexible membranes; glass fiber reinforced plastics/resins; steel coated with zinc, epoxy, vinyl, and asphalt; reinforced concrete.
Medium (minimum of 20 yr)	Reinforced concrete; glass-fused steel.
Long (minimum of 50 yr)	Reinforced concrete.

1/ The durability and estimated life of reinforced concrete is a function of the design criteria and the quality of the concrete. A key aspect affecting durability is corrosion of the reinforcement, which is directly related to cracking (design stress), and the reinforcement cover. The quality levels of reinforced concrete are discussed under "Structural Design," "Design Criteria."

Design Criteria

Service life. The structure shall be planned, designed, and installed to provide a minimum service life of 10 years.

Size. The volume of the structure shall be large enough to store accumulated wastes, bedding, wash water, and needed dilution water for the maximum period during which such wastes cannot be processed for energy or be applied to the land because of operational restrictions, weather, or crops. Provisions should be made to insure that outside runoff does not flow into the structure. If suitable provisions cannot be made, however, the anticipated volume of runoff likely to enter the structure must be included in the required volume. The design capacity must allow for any direct rainfall and snow. An allowance of at least six inches shall be provided in the bottom of the storage tank to

accommodate materials that are not removed during emptying. A minimum of six inches shall be provided for freeboard. Data in chapter four of the Agricultural Waste Management Field Manual or reliable local information can be used in determining the quantity of waste production.

To reduce the necessity of spreading on frozen ground, storage capacity for a minimum of 150 days should be provided. Storage up to 180 days is desirable and recommended especially for northern areas of the state or where wet soils prevent spreading in early spring. If storage for less than 150 days is provided, adequate conservation treatment must be on the land where spreading will be performed to reduce runoff to a minimum. Restrict application to areas with a minimum pollution hazard. In no case will storage for less than 120 days be used in design.

Tables on pages WI-4-1 and WI-4-2 of the Agricultural Waste Management Manual are a guide to manure production for various animals.

The volume of wash water should be determined by actual measurement or estimated by a reliable method such as calibration of each faucet, hose, or spray nozzle and applying the rate of water used to the time of operation.

Liquids must be retained within stacking facilities, collected in a holding pond, or applied directly to fields with a minimum pollution hazard so that liquids do not flow into drainage ditches, streams, or lakes. Slurry or semi-liquid manure without bedding, such as that from free-stall dairy housing, does not lend itself to stacking at depths greater than three to four feet. Stacking facilities for such wastes should be designed, using the same criteria as for holding tanks or holding ponds. Liquids from stacking facilities shall be carried in liquid-tight conduits or flumes if adequate soil depth over bedrock on high ground water level does not exist.

The shape and height of the stack shall be determined by the method used to stack the manure, amount of bedding in the manure, and the farmer's desire. Manure with little bedding will slump and cannot be stacked as high as manure with considerable bedding. The angle of repose of stanchion barn manure containing straw is approximately 40° to 50°.

A holding tank must be constructed on soils which will provide even settlement. When unequal settlement may result or rock formations encountered, special designs must be considered.

Separation of precipitation. Precipitation which collects on waste storage ponds must be drained or pumped away when conventional manure handling equipment is used for removal of the wastes. This polluted runoff must be collected and disposed of in a safe manner. Picket dams may be used to separate the water resulting from precipitation when the manure contains bedding. The pickets should be placed vertically and designed to withstand a horizontal loading equal to 45 pounds per cubic foot. The picket dam should extend up the ramp to a point where the wastes are first removed.

Structural loadings. Waste storage structures shall be designed to withstand all anticipated loads. Loadings include 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.

The lateral earth pressure should be calculated from soil strength values determined from the results of appropriate soil tests. If soil strength tests are not available, the minimum lateral earth pressure values indicated in table 1 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the structural stiffness or wall yielding as follows:

1. Rigid frame or restrained wall. Use the values shown in table 1 under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.

2. Flexible or yielding wall. Use the values shown in table 1 under the column "Freestanding Wall," 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 thickness to height ratio not more than 0.085.

Table 1. 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	Unified classification	Free-standing wall	Frame tanks	Free-standing wall	Frame tanks
Clean sand, gravel, or sand-gravel mixtures[4] (maximum 5% fines)	GP,GW,SP,SW	30	50	80	90
Well-graded sand, silt, and clay mixtures (less than 50% fines)	SC, SC-SW, GM, GM-GP, SM, SM-SW, SM-SP, GC, GM-GW, GC-GP, GC-GW	35	60	80	100
Low-plasticity silts and clays with significant sand and gravel of fine silty and clayey sands (more than 50% fines)	Gravelly sandy CL and ML, or fine SC or SM	45	75	90	105
Low-to medium-plasticity silts and clays lacking in sand and gravel (more than 50% fines)	CL, ML	65	85	95	110
High liquid limit silts and clays	CH,MH[5]	--	100	115	115

1/ For lightly compacted soils (85% to 90% maximum standard density). Includes compaction by use of typical farm machinery.
2/ Also below seasonal high water table. if adequate drainage is provided.
3/ Includes hydrostatic presure.
4/ Generally only washed materials are in this category.
5/ Unsuitable for backfill.

An internal hydrostatic load of 60 lb/ft^2/foot of depth shall be used for design. If heavy equipment is to be operated within five feet of the walls, a surcharge (horizontal pressure) of 100 lb/ft^2 on the wall shall be added. Covers for waste storage structures shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378 (Floor and Suspended Loads on Farm Structures Due to Use) and in ASAE EP393 (Solid and Liquid Manure Storage) shall be the minimum used. The actual axle load for tank wagons having more than a 2,000-gallon capacity shall be used. If the facility has a roof, snow and wind loads shall be as specified in ASAE S288 (Designing Buildings to Resist Snow and Wind Loads). If a waste storage structure is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design.

Potential uplift pressures shall be eliminated by drainage or be included in the structural design (including bouyancy and flotation).

Structural design. The structural design shall consider all items that will influence performance, such as design analyses, methods, and assumptions; construction methods and quality control; and operational exposure, use maintenance, and repair.

Storage 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 storage tanks shall be designed to accommodate equipment for loading, agitating, and emptying and shall be equipped with grills or secure covers for safety and odor and vector control.

Aboveground waste storage structures shall have adequate footings extending below the anticipated frost depth.

Minimum requirements for waste storage structures are specified below:

1. Steel. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.

2. Timber. NFPA National Design Specifications for Wood Construction.

3. Reinforced concrete.

Service life	Specification
Short (minimum of 10 yr)	ACI 318.
Medium (minimum of 20 yr)	ACI 318 modified as follows: (a) Maximum steel yield level shall be equal to that of Grade 40. (b) The required strength to resist all anticipated loads shall be based on a minimum load factor of 1.8.
Long (minimum of 50 yr)	ACI 350 R.

4. Masonry concrete. ACI 531.

5. Nonstructural concrete slab. The minimum thickness of slabs for tanks shall be 5 inches, but for slabs cast on plastic over sand, the minimum thickness shall be 4 inches. The minimum thickness of slabs for stacking facilities shall be 4 inches. The minimum reinforcement for slabs with a span of 30 feet or less shall be equal to that of 10 by 10 gage, 6 inches by 6 inches welded wire fabric. Slabs having a span greater than 30 feet shall be provided with expansion joints at a maximum spacing of 30 feet or shall have additional steel reinforcement.

   Concrete slabs for solid manure temporary stacks or storage platforms shall have a minimum thickness of five inches. Expansion joints shall contain water.

6. Flexible membranes. Flexible membranes shall meet or exceed the requirements of flexible membrane linings specified in SCS standard 521-A.

7. Coatings. Coatings shall be approved in accordance with procedures in the National Engineering Manual (210-512.20 to 512.23).

8. Glass fiber reinforced plastics/resins and glass-fused steel. Products shall be approved in accordance with procedures in the National Engineering Manual (210-512.20 to 512.23).

Safety. Entrance ramps shall be no steeper than 8 horizontal to 1 vertical. Warning signs, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to insure the safety of humans and livestock. Ventilation and warning signs must be provided for enclosed wasteholding structures, as necessary, to prevent explosions, poisoning, or asphyxiation. Pipelines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings.

Operation and Maintenance

Operation and maintenance shall be in accordance with the requirements specified in the overall waste management plan.

Plans and Specifications

Plans and specifications for waste storage structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

All SCS plans, including approved standard structural plans, must be submitted to the person(s) responsible for approval as indicated on Job Approval Authority prior to installation. These plans are to include details concerning the overall plan and layout of the facility. It should show location of milkhouse, well, proposed method of emptying tank, etc. Standard plans can often be used for single components of an overall plan.

When structures which have been prequalified are installed, a statement from the supplier shall be obtained indicating the drawing number applicable and that the requirements of the specifications and the drawings have been equaled or exceeded.

Soil Conservation Service

Specifications Guide

Construction of waste storage structures shall be completed in accordance with the following Wisconsin Constructions Specifications as applicable:

Number	Title
2	Excavation
3	Earth Fill
4 or 4a	Concrete
8	Drain Fill