NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(No.)

CODE 313

DEFINITION

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

PURPOSE

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

CONDITIONS WHERE PRACTICE APPLIES

- The storage facility is a component of a planned agricultural waste management system
- Temporary storage is needed for organic wastes generated by agricultural production or processing
- The storage facility can be constructed, operated, and maintained without polluting air or water resources
- Soils, geology, and topography are suitable for construction of the facility

The practice applies to:

- Waste storage pond facilities utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to farm buildings, agricultural land, or township and county roads
- Fabricated structure facilities such as tanks, stacking facilities, and pond appurtenances

Waste storage facilities described in this standard are waste storage ponds, fabricated structures, and short term storage basins.

The short term storage basin may be used to store manure, bedding, spilled feed, runoff, etc., from open concrete lots for swine or for other livestock enterprises, where the producer's management objectives may include scraping solids from the feedlot and into the basin, utilizing a frequent hauling system, and having a manure management plan that is consistent with these objectives.

Additional considerations include situations where:

- solid settling is nearly impossible to achieve
- long term total containment is not practical
- total containment does not meet the producer's management objectives

Short term storage basins for confinement systems shall not be used except as allowed in Criteria – Stacking Facilities. A manure management plan (nutrient management or waste utilization plan) shall be developed for all systems.

Federal, State, and Local Laws

This standard is in addition to all federal, state, and local laws governing waste management, pollution abatement, and health and safety. The owner shall be responsible for obtaining all required permits and for compliance with such laws and regulations. Certification of compliance with this standard and specification **DOES NOT** ensure compliance with other federal, state, and local requirements.

Any work involving the discharge of dredged or fill material into wetlands or other waters of the United States may require a permit according to Section 404 of the Clean Water Act.

PLANNING CONSIDERATIONS

Waste storage facilities shall be located as close to the source of waste and polluted runoff as practical. In addition, consideration shall be given to prevailing winds and landscape elements such as building arrangement, landform, and vegetation to minimize odors and visual resource concerns.

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

Roof systems for manure storage facilities or feedlots may be used to reduce contaminated runoff. Such structures shall be designed to prevent manure under the roof from becoming a pollution problem.

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

Due consideration shall be given to economics, the overall waste management system plan, conservation needs, and safety and health factors. The appropriate materials will be used to design and construct the system with a service life and durability to meet the goals and expectations of the producer.

Karst Areas. Locating animal waste storage facilities in karst regions creates particular concern due to the potential for sinkholes to develop beneath a structure. This would almost certainly cause failure, allowing waste to drain into the underlying bedrock and potentially contaminate groundwater.

Karst areas are characterized by sinkholes, caves, and underground drainage, making groundwater particularly susceptible to contamination. Portions of northeast and east central Iowa containing shallow limestone and dolomite rock exhibit karst features. These features develop where dissolution of these carbonate rocks by groundwater creates voids in the rock.

Sinkholes can develop when these voids occur near the ground surface and overlying material collapses. This collapse can be slow or instantaneous.

Although sinkholes are generally located in specific rock formations, predicting where and when they will occur is almost impossible.

The size and depth of the void and thickness and strength characteristics of the overlying material are important factors in sinkhole development.

In areas that exhibit sinkhole activity (sinkholes within ½ mile), a geologist should be consulted before locating any storage facility. Bedrock maps, soil surveys, and visual observation should be used to identify these areas. Several observations that may help to evaluate a potential site are:

- Is the landscape position of the proposed site located on a ridge, side slope, or drainage way? Certain landscape positions may be closer to bedrock, in a certain rock formation, or have greater infiltration rates.
- What is the landscape position of the proposed site in relation to landscape position of nearby sinkholes?
- If possible, identify different rock formations and their location with respect to the proposed site location. Is the site to be located in a formation susceptible to sinkholes?

The Iowa Department of Natural Resources (IDNR) may have special criteria or rules for sites that are proposed in areas that exhibit karst features. When appropriate, these proposed sites shall be discussed with IDNR during planning or preliminary design.

CRITERIA

Storage Period. The storage period is the length of time anticipated between emptying events. It shall be based on the timing required for environmentally safe waste utilization considering the climate, crops, soil, equipment, and federal, state, and local laws, rules, and regulations. The maximum and minimum storage periods are different for various types of facilities.

Storage ponds and fabricated structures designed for manure storage shall have a minimum storage period of 120 days and a maximum storage period of 14 months (425 days).

These facilities must be completely emptied at least once per year. Alternative runoff control systems as listed in Iowa Administrative Code, Title 567, Chapter 65, Division II - Open Feedlot Operations, are also acceptable for open feedlot systems where total containment is not required.

Short term storage basins shall have a maximum storage period of 45 days. The design storage volume for a waste storage facility is equal to its minimum required volume**.**

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

Embankments. The minimum elevation of the top of the settled embankment shall be 2 feet (freeboard) above the required storage volume. This height shall be increased by not less than 5 percent to ensure that the top elevation will be maintained after settlement. The minimum top width shall be as shown in the Minimum Top Width Table below. The combined side slopes of the settled embankment shall be not less than 5 horizontal to 1 vertical, with neither the inside or outside slope steeper than 2.5h:1v.

Minimum Top Width Table

Fill Height* (feet)	Minimum Top Width (feet)
Up to 5	8
5 to 14.9	10
15 to 24.9	12
25 to 35	14

***** Fill height is defined as from top of the embankment to the lowest point on the centerline of embankment.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. All facilities should be fenced or have a structural cover, as necessary, to prevent people and/or livestock from using it for other than its intended purpose. Safety stops and gates should be installed and maintained at push-off and load-out areas. Warning signs, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs should be provided for covered waste holding 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.

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

Flexible Membranes. Flexible membranes shall meet or exceed the requirements of flexible membrane linings specified in Pond Sealing or Lining, Flexible Membrane Lining (521A).

Stacking Facilities. For confinements, short term stacking facilities are allowed. Design capacity shall be such as to contain a minimum of the solid waste volume generated at the facility during a 1-month period of operation. No runoff will be allowed from the stacking facility.

Vegetative Treatment System

Vegetative Treatment Systems (VTS), commonly called alternative technology (AT), may be used for concentrated animal feeding operations (CAFO's) in the place of conventional alternative runoff control systems. CAFO sized VTS systems must be evaluated to ensure that it meets the Effluent Limitation Guidelines (ELG's) of the CAFO regulations.

All open lot operations shall have solid settling as a part of the manure management system. Alternative Treatment System components shall consist of a vegetative infiltration basin (VIB) followed by a vegetative treatment area (VTA) or a stand alone vegetative treatment area (VTA). Other components may be acceptable if equivalent performance of Environmental Protection Agency (EPA) regulations are met and approved by IDNR. Evidence of equivalent performance must be provided by the landowner.

Site selection and design guidelines are found in Iowa Administrative Code, Title 567, Chapter 65, Division II – Open Feedlot Operations, and the NRCS guidance document "Vegetative Treatment System for Open Lot Runoff." CAFO sized systems not meeting the ELG's shall make system modifications as directed by IDNR or install a conventional runoff control system.

DESIGN STORAGE VOLUME AND FREEBOARD REQUIREMENTS

CONFINEMENT - WASTE STORAGE FACILITY

POND and FABRICATED STRUCTURES (TANKS)

Design Storage Volume	Freeboard
120 days minimum 14 months maximum (425 days to allow for seasonal variations)	
NRCS ➢ Manure, wastewater, and other wastes produced during storage period ➢ Precipitation minus evaporation during the storage period ➢ Normal runoff from the facility's drainage area during the storage period ➢ 25-yr, 24-hr precipitation on the surface of the facility and from the facility's drainage area ➢ Residual storage (6" minimum) ➢ Additional storage as may be required to meet management goals or regulatory requirements	PONDS NRCS Top elevation shall be 2' above the design storage volume. IDNR Top elevation shall be a minimum of 2' above the design storage volume. TANKS NRCS Top elevation shall be the greater of: ➢ 1.5' above the design storage volume OR ➢ 1' above the water surface resulting from containment of the 25-yr, 24-hr precipitation above the design storage volume. IDNR Top elevation shall be a minimum of 1'-8" above the design storage volume

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SHORT TERM STORAGE BASIN –Liquid Manure Systems

Not allowed for confinement systems.

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STACKING FACILITY – Solid (Stackable) Manure Systems

Short term stacking facilities are allowed for confinement systems – see Criteria section.

DESIGN STORAGE VOLUME AND FREEBOARD REQUIREMENTS

OPEN LOT - WASTE STORAGE FACILITY

POND and FABRICATED STRUCTURES (TANKS)

Design Storage Volume	Freeboard
120 days minimum 14 months maximum (425 days to allow for seasonal variations)	
NRCS ➢ Residual storage (6" minimum) ➢ Manure ➢ Waste/wash water ➢ Precipitation - evaporation on pond during storage period ➢ 25-yr, 24-hr precipitation on pond ➢ Normal runoff from feedlot during storage period ➢ Runoff from 25-yr, 24-hr storm on feedlot ➢ Normal runoff from outside of feedlot ➢ Runoff from 25-yr, 24-hr storm from outside the feedlot	NRCS Top elevation shall be a minimum of 1' above emergency spillway crest. If an emergency spillway is not used then the top elevation shall be a minimum of 1' above the water surface resulting from the containment of the runoff from a 25-yr, 24-hr storm above the design volume.
OR	
IDNR Iowa Administrative Code Chapter 65, Appendix A	IDNR 1' minimum above emergency spillway flow

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SHORT TERM STORAGE BASIN

45 days maximum

NRCS ➢ 25-yr, 24-hr precipitation on basin ➢ 25-yr, 24-hr runoff from feedlot ➢ Volume of manure and other waste trapped in or scraped into the basin during the storage period	NRCS *Concrete* 0.5' minimum above design storage volume *Earthen* Top of embankment shall be a minimum of 1' above the design storage volume.

ADDITIONAL POND CRITERIA

Location. Waste storage ponds, if located within floodplains, shall be protected from inundation or damage from a 100-year flood event.

Iowa Law has established minimum separation distances from the following:

- drainage wells and sinkholes
- lakes, rivers, and streams
- navigable rivers and streams
- public and private wells
- residences, businesses, etc.
- public use areas

Soil and Foundation. Locate the pond on soils of slow to moderate permeability or on soils that can seal through sedimentation and biological action. Avoid gravelly soils and shallow soils over fractured or cavernous rock. If self-sealing is not probable, the storage pond shall be sealed by mechanical treatment or by the use of an impermeable membrane. The pond shall have a bottom elevation that is a minimum of 2 feet above the high water table. Artificial drainage to lower the water table is allowable where effective. This will be a site specific, special situation that may require additional foundation investigation for design.

Sites requiring IDNR permits require soil borings and hydro-geological review as specified in the IDNR rules and procedures.

Investigations for pre-existing tile must be conducted at all sites.

The maximum percolation rate on all earthen lined storage sites shall be equal to or less than the maximum as specified by IDNR regulations. Appropriate permeability testing shall be conducted unless it is possible to do correlation of soil origin, texture, dry density, and permeability data from other tests.

Ten feet of vertical separation is recommended between the bottom of the constructed pond and bedrock formations but in no case shall there be less than 4 feet. Isolated pockets of sand and gravel in soils shall be over-excavated and covered with a minimum 2 feet thickness of compacted low permeability material.

Karst Areas. Karst areas require additional precautions. If sinkholes occur within 1 mile of the proposed construction site and the geologist believes the site is located within a geologic formation with a high potential for sinkholes, the following minimum requirements shall be used for thickness of material between the bottom of the facility and the bedrock surface noted below. The presence of sinkholes may require the facility to be relocated to a different site.

- for earthen lined facilities (open feedlots only):
  - 25 feet of suitable material exist between structure bottom and carbonated bedrock, limestone, or dolomite
- for a facility with a synthetic liner:
  - a minimum of 4 feet of material; 10 feet is recommended

The material shall be fine grained with low permeability, such as described by IDNR rules. Additional precautions such as a greater thickness of fine grain material, a synthetic lining, moving to a different site, or other alternatives may be required if determined necessary by site conditions.

Proposed sites that may be expected to require construction permits shall be discussed with IDNR prior to final design to give them an opportunity to evaluate the site.

Outlet. No outlet capable of automatically releasing storage from the required storage volume will be allowed. Manually operated outlets shall be of permanent type designed to resist corrosion and plugging. Gravity unloading is not allowed**.**

Emptying Facilities. Some type of facility shall be provided for emptying the pond. It may be a dock, a pumping platform, a retaining wall, a ramp, etc. It is recommended that ramps used by equipment to haul liquids shall have a slope of 10 horizontal to 1 vertical (10h:1v) or flatter. Ramps used by equipment to haul slurry, semi-solid, or solid waste shall have a slope of 10h:1v or flatter. Steeper slopes may be considered if special traction surfaces are provided.

Provisions 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 size and shape of the pond and type of seal used to reduce the permeability.

Safety stops and gates shall be installed and maintained at push-off and load-out areas.

ADDITIONAL FABRICATED STRUCTURE CRITERIA

Foundation. The foundations of fabricated 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 shall be calculated from site specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data are available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 1 or a nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

Table 1. 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/] International Building Code, 2006, International Code Council (ICC)

Structural Loading. Fabricated 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 shall be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in Technical Release 74. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 2 shall be used.

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

- Rigid frame or restrained wall. Use the values shown in Table 2, under the column “Frame Tanks,” which gives pressures comparable to the at-rest condition.
- Flexible or yielding wall. Use the values shown in Table 2, 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 wall thickness to height of backfill or height of wall ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 lbs/ft^2 where the stored waste is not protected from precipitation. A value of 60 lbs/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 Structure Due to Use, and in ASAE EP393.3, 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 or lot is to have a roof, snow and wind loads shall be as specified in ASCE 7-05, Minimum Design Loads for Buildings and other Structures. 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 the 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, agitation, and emptying. These openings shall be equipped with grills or secure covers for safety and for odor, pest and disease control.

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

Table 2. 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	80
Gravel, sand, silt, and clay mixtures (less than 50% fines) Coarse sands with silt 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 in this category.
[6/] Not recommended. Requires special design if used.

Minimum requirements for materials and fabricated structures are found in the following references or comments:

- **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

Concrete slabs on grade. Slab design shall consider the required performance and the critical applied loads along with the subgrade material. 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 control joint spacing of 10 feet. Concrete strength (28-day compression test) shall be 3,500 psi minimum. Control 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 reinforcing steel shall be based on subgrade drag theory.

When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure, such as described in ACI 360, shall be used.

SHORT TERM STORAGE BASIN CRITERIA

- This practice is intended to store liquids and/or solids for a maximum of 45 days.
- Watertight stoplogs, sumps, and other appurtenances may be used to facilitate clean out of the basin.
- Landowner equipment must be adequate for waste removal.
- Adequate land or storage must be available for proper nutrient application.
- The basin must be cleaned frequently enough to meet management and design objectives.
- Flow from the emergency spillway or from overtopping shall be directed away from the facility to minimize damage from erosion.

Short term storage basin storage capacity and freeboard requirements shall be as defined in Criteria – Staking Facilities in the Design Storage Volume and Freeboard Requirements, Open Lot – Waste Storage Facility section of this standard.

Structural components shall conform to the fabricated structure criteria in this standard.

Entrance ramps should be no steeper than 10 horizontal to 1 vertical.

CONSIDERATIONS

Secondary Containment. 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. The following should be considered 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

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets:

- Outlet gate locks or locked gate housing
- Secondary containment
- Alarm system
- Another means of emptying the required volume

The following considerations are additional measures for minimizing the potential of waste storage pond liner failure:

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

Air Quality. To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor, other practices such as Anaerobic Digester – Ambient Temperature (365), Anaerobic Digester – Controlled Temperature (366), Waste Facility Cover (367), and Composting Facility (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. (see Waste Utilization (633))

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

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.

The following list of Construction Specifications is intended as a guide to selecting the appropriate specifications for a specific project. The list includes most, but may not contain all, of the specifications needed for a specific project:

IA-1 Site Preparation
IA-3 Structural Removal
IA-5 Pollution Control
IA-6 Seeding and Mulching for Protective Cover
IA-11 Removal of Water
IA-21 Excavation
IA-23 Earthfill
IA-24 Drainfill
IA-26 Salvaging and Spreading Topsoil
IA-27 Diversions
IA-31 Concrete
IA-32 Concrete for Nonstructural Slabs
IA-45 Plastic (PVC, PE) Pipe
IA-81 Metal Fabrication and Installation
IA-83 Timber Fabrication and Installation
IA-92 Fences

OPERATION AND MAINTENANCE

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 plan shall contain the operational requirements for emptying the storage facility such as the requirement that waste shall be removed from storage and utilized at locations, times, rates, and volume in accordance with the overall waste management plan. In addition, for basins and ponds, the plan shall include the requirement that following storms waste shall be removed at the earliest environmentally safe period to ensure that sufficient capacity is available to accommodate subsequent storms.

Operation of the basin shall be performed according to the written plan provided for in the overall waste management plan.

Necessary maintenance will be performed in a timely manner in order to protect the facility and its ability to perform as planned.

Equipment operators should not operate equipment on ramps with slopes steeper than 10h:1v.

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.

REFERENCES

USDA-NRCS, National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH)