Applicable Standards

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TOWN OF EMERALD
ST. CROIX COUNTY, WISCONSIN

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NRCS Conservation Practice Standards

WASTE STORAGE FACILITY

(No.)

Code 313

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A waste storage *impoundment*[1] made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a *structure*.

II. Purpose

To temporarily store wastes such as manure, *manure processing derivatives, leachate, wastewater*, and *contaminated runoff* from agricultural sources in a manner which safeguards the environment.

This standard does not preclude the addition of other off farm organic materials, pending approval by the appropriate regulatory authority.

III. Conditions Where Practice Applies

This standard applies to:

- waste storage impoundments or structures up to 30 million gallons in size;
- construction of a storage facility in areas where the soils, geography, and topography are suitable and where the construction, operation, and maintenance will protect the soil and water resources;
- facilities that are part of a planned agriculture waste management system intended to meet the facility management goals, regulatory requirements, or *nutrient management plans* by providing storage of waste;
- waste storage facilities utilizing embankments with a maximum *effective height* of 25 feet and where damage resulting from failure would be limited.

This standard does not apply to the storage of human waste or the unstacked waste that accumulates in animal housing units.

IV. Federal, Tribal, State and Local Laws

Waste storage facilities shall comply with all federal, tribal, state, and local laws, rules or regulations. The operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state, or local laws governing waste storage facilities.

V. Criteria

The following criteria establish **minimum** allowable limits for design parameters, acceptable installation processes, or performance requirements.

A. General Criteria

The following general criteria apply to this practice.

1. Management Assessment

A management assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed with the owner/operator to explore options and to determine the purpose of storage components, available resources, manure disposal schemes, sand and manure solids separation methods, and waste characteristics.

When the intent of the owner/operator is to process and/or treat the various waste streams within the *animal production area*, the designer shall provide a narrative describing the system. The description will include the intent and purpose of the treatment or processing strategies relative to land spreading or waste distribution strategies, stabilization of organic by-products, separation of sand bedding, reducing pollutant loads, nutrient concentration, waste consistencies, odor control, energy production, and volume reduction.

The management assessment shall address the following as appropriate to the system being designed:

a. Waste Characterization.

1) Sources, volumes and consistency of manure, contaminated runoff, manure processing derivatives, leachate,

[1]Words in the standard that are shown in italics are described in VIII. Definitions. The words are italicized the first time they are used in the text.

wastewater, and other inputs to the waste storage facility.

2) Animal types.

3) Bedding types and quantity.

b. Land base available for utilization of waste.

c. Planned storage period.

d. Waste handling and transfer methods from the waste source to the storage facility.

e. Facility waste removal methods.

f. Storage facility liner possibilities and preferences.

g. Access needs and limitations.

h. Safety needs, including those to address the hazards of manure gases.

i. Labor and equipment needs.

j. Potential odor concerns.

k. Provisions for facility expansion.

2. Site Assessment

A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of a proposed waste storage facility and transfer components. The assessment shall include input from the owner/operator. The site assessment shall include:

a. Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, wells, springs, floodplains, surface waters, surface drains, drain tile, utilities, overhead lines, *cultural resources*, and wetlands.

b. Test pit or soil boring logs, soil test results, a soil survey photo, and a narrative describing the design parameters that have been derived from the soils data. Test pit soil or boring criteria include:

1) The number and distribution needed to characterize the subsurface (soils, saturation, and *bedrock*). Test pits or borings shall be added if there is inconsistency within or between test pits or borings.

2) Based on the facility *footprint* there shall be a minimum of one test pit or boring per 15,000 square feet of footprint, with a minimum of two per facility. Test pits and borings used to meet these criteria shall be located in the footprint or no more than 100 feet from the footprint. These test pits/soil borings shall extend to bedrock, a free water surface, or to a minimum depth to ensure subsurface saturation and bedrock separation distances required in this standard are achieved.

3) Soil layers shall be described with respect to thickness, texture using the Unified Soil Classification System (USCS), Munsell color, presence and color of redoximorphic features (soil mottling), *gleyed soil* and moisture condition.

4) The elevation of bedrock and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.

5) The upper elevation of all saturated layers encountered.

c. Locations of *sinkholes* and other *karst* features and direct conduits to groundwater within 1,000 feet of the facility.

d. Locations, dimensions and elevations, soil volumes, soil samples, testing results, and reclamation plans of any borrow areas. Characterize borrow areas according to Section V.A.2.b.(1)), V.A.2.b.(3), and V.A.2.b.(4). Test pits for clay borrow source evaluation shall be completed on a maximum 100-foot grid.

e. Identification of potential impacts from failure of the embankments, liners, or structures.

3. Flood Prone Areas

Waste storage facilities located in *flood prone areas* shall be protected from inundation, structural damage, and instability. These facilities shall be designed to accommodate any additional loading resulting from static water

levels or saturated soils. The lowest point at which floodwater could enter the waste storage facility shall be 2 feet above the maximum elevation of flow resulting from a 100-year, 24-hour rainfall event.

4. Location

Waste storage facilities shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized. Potential failures and environmental impacts identified in the site assessment shall be addressed in the design phase, the operation and maintenance plan, and/or the emergency action plan.

5. Design Storage Volume

Design storage volumes shall be calculated with the procedures and default values found in the Wisconsin supplement to Chapter 10 of the NRCS Agricultural Waste Management Field Handbook (AWMFH) or site-specific estimates and measurements documented in the plan. The design storage duration and volume shall be consistent with the nutrient management plan and emptying schedule. Design volume shall include the sum of the following during the storage period:

- Manure, bedding and other wastes.
- The volume of wastewater from all sources that is anticipated to enter the storage facility. The wastewater volume shall be based on default values or estimates and measurements documented in the plan.
- Normal precipitation less evaporation on the surface of the facility.
- Runoff volumes from the drainage area for design storage duration.
- 25-year, 24-hour precipitation on the surface of the facility.
- 25-year, 24-hour runoff volume from the drainage area.

6. Maximum Operating Level

The maximum operating level for liquid or slurry waste storage facilities shall be the storage level that provides for the design storage volume listed in Section V.A.5 less the volume of precipitation and runoff from the 25-year, 24-hour storm event. See Figure 1.

A permanent marker or indicator that does not compromise the integrity of the liner shall be installed at the maximum operating level. The stored waste shall be managed such that it remains below the maximum operating level during normal operating conditions. State or local codes may require additional markers.

A contingency plan shall be implemented when the maximum operating level is reached.

7. Extra Depth for Safety

A minimum of one foot of depth shall be added to the design storage volume to reduce the risk of overtopping. This depth is not intended to add storage capacity. See Figure 1.

8. Remaining Waste and Sumps

An additional depth shall be added to the facility to accommodate the waste that cannot be routinely removed during emptying. A minimum of two feet shall be added to storage depth for facilities with side slopes and one foot for vertical walled facilities. The additional storage depth can be reduced if a sump is installed or other provisions to empty the facility have been made.

9. Separation from Subsurface Saturation or Bedrock

The separation is determined to be the closest distance from any point on the inside surface (bottom and sides) of the storage facility to the feature from which separation is required.

The definition of subsurface saturation is not intended for application in any context other than to protect structures installed from hydrostatic loadings.

a. For the purposes of this standard, factors used to identify subsurface saturation shall include observed saturation, gleyed soil, gray mottles, and soil color in conjunction with nearby surface water features. The highest subsurface saturation elevation in a test pit/soil boring will be identified by any of the following soil properties.

   1) Free water or wet soil identified by glistening, due to the slow release of water.

2) Gleyed soil, that may extend uninterrupted from an observed free water surface.

3) The presence of distinct gray redoximorphic features with a chroma of 2 or less based on Munsell color charts.

4) Depleted matrices having a value of 4 or more and chroma 2 or less based on Munsell color charts. In some cases soil parent materials have a natural color of 2 chroma or less or gleyed color that is not due to saturation. In these cases other indicators may be used: landscape position, elevation or soils in relation to nearby water features.

b. In soils not conducive to mottling, such as sand, the subsurface saturation elevation shall be established by evaluating the soil morphology of the soil profile. Other indicators that may be considered in making the determination are the position of the soil in the landscape, topography, nearby wetlands and well construction logs.

c. Subsurface saturation, if encountered shall not be drained (or have water-bearing layers removed) except as described for *perched conditions*. Perched conditions may be drained or water-bearing materials removed to achieve separation distances in the tables and relieve hydrostatic loads on the facility. Documentation to demonstrate that subsurface saturation is perched and of drainable extent or its effects otherwise eliminated shall be included in the site assessment. All *drainage systems* shall drain by gravity. The effect of temporary tailwater on the structure or liner and the effects of outletting to perennial and intermittent waterways shall be evaluated. A drainage system shall be located around the outside perimeter of the facility footprint and drain to a surface outlet. A drainage system may also be located around the outside perimeter of an impoundment floor within the facility footprint if the drainage system outlets to a manhole that can be monitored for liquid level, and pumped if needed to remove liquids.

d. If the site assessment indicates artesian features, a hydrogeologic and geotechnical evaluation of the site shall be completed to determine the site suitability for an in-ground waste storage facility.

e. Excavation of bedrock is permitted to achieve the required separation distance as specified in the tables. Bedrock shall not be removed by blasting. The exposed bedrock surface shall be evaluated to ensure a structurally sound base for liner or other soil material. Fractures or voids shall be treated to prevent migration of soil material. The surface of excavated bedrock shall have a positive grade, minimum of 1 percent, under and away from the storage facility, as to prevent any significant ponding on the rock surface. If bedrock is excavated, the material placed between the liner and the bedrock shall have a minimum of 20% passing the #200 sieve.

10. Safety Design

Safety design shall identify and minimize the hazards to animals and people. In particular, waste storage facility designs may create *confined spaces*, which may pose significant hazards in terms of the inhalation of poisonous gases, asphyxiation, or explosion. At a minimum, safety design shall include the following.

a. Warning signs, fences, ladders, ropes, rails, and other devices shall be provided, as appropriate. A fence is required unless the waste storage facility has vertical walls 5 feet above the ground surface or the waste storage facility has a cover that will support foot traffic. Fences shall discourage passage of livestock and people. The fence design needs to consider the production site conditions.

b. Safety stops, gates, or both installed at push-off ramps and load-out areas of impoundments and structures to prevent accidental entry of machinery.

c. Equipment access ramps and embankment slopes shall be compatible with the equipment intended to be used.

d. Confined spaces where human entry may occur shall be designed and operated in compliance with the provisions contained in ASABE EP470, Manure Storage Safety.

11. Engineering Design Documentation

Engineering design documentation shall be prepared in accordance with the criteria of this standard. The design documentation shall include:

- Management assessment,
- Site assessment,
- Operation and maintenance plan,
- Construction plan,
- Construction Quality Assurance Plan,
- Engineering computations, such as runoff, structural (unless using NRCS Standard Drawings), earthwork quantities, and volumetric computations for sizing of waste storage facility.

Documentation for siting temporary, unconfined stacks of manure and derivatives outside the animal production area shall include:

- Management assessment,
- Site assessment, and
- Location maps, soils maps, and USGS quadrangle maps.

12. Construction Plans and Specifications

Construction plans and specifications for materials and installation shall be prepared to serve as a basis for construction of the practice. Construction plans and specifications shall include, as applicable:

- Plan view of system layout.
- Minimum of two cross sections, perpendicular to each other, for each waste storage facility.
- Structural details of components sufficient to clearly show the construction requirements.
- Details for joining different liner types or new liners to existing liners.
- Locations, sizes, and type of pipelines and appurtenances, including a profile of the waste transfer system.
- Requirements for foundation preparation and treatment, including bedrock treatment.
- References to components supplied by others (pumps, etc.).
- Vegetative requirements.
- Surface Drainage/Grading plan.
- Subsurface drainage details.
- Location of soil test pits within 100 feet of the facility footprint on the plan view, and a summary of soil logs plotted on the cross sections or profile.
- Identification of borrow source location(s)
- Safety features, roof covers, fencing, ladders, and safety signs.
- Construction site erosion control practices
- Approximate location of utilities and notification requirements.
- Specifications for materials and installation.
- Signature of the person responsible for the design, their engineering seal, NRCS Job Approval or WDATCP Agricultural Engineering Practitioner Certification level, the date, and a statement attesting the plans meet the requirements of the WI FOTG 313 Conservation Practice Standard.
- Other site-specific information necessary to construct the waste storage facility.

13. Construction Quality Assurance Plan

A construction quality assurance plan is required that describes the type and frequency of testing, items requiring observation, and the documentation required. The plan shall be implemented by a person with NRCS Job Approval, WDATCP Agricultural Engineering Practitioner Certification, a Wisconsin registered professional engineer, or staff under the direction and control of the person holding the aforementioned credentials. The construction quality assurance plan shall address all the following items:

- Contact information and responsibilities of key parties (including owner, designer, construction observer, and contractor).
- Pre-construction meeting agenda items (including quality assurance plan, construction plans and specifications,

design change procedures, and critical project-specific items).
- Observation and construction verification (including items to be verified, sequencing, layout/staking, notification requirements, and onsite materials testing documentation).
- Items to be noted on as-built plans, job diary, and other certification (attesting) documentation.

14. Operation and Maintenance

An operation and maintenance plan shall be developed that is consistent with the purposes of this practice, intended life of the components, safety requirements, and the criteria for the design. At a minimum, the plan shall include:

a. A narrative describing the purpose of the system or structure and how it is intended to operate. This narrative should include design criteria such as number and type of animals, type of waste, type of bedding, days of storage, method for emptying, vehicle sizes intended to operate within or near the system and other pertinent operational information.

b. A requirement that waste be removed and utilized in accordance with Wisconsin NRCS Field Office Technical Guide, Section IV (WI FOTG), Standard 590, Nutrient Management.

c. Requirements for location and methods of waste removal in order to maintain liner integrity.

d. Requirements for monitoring the waste level relative to the permanent maximum operating level markers or indicators.

e. Requirements for inspecting and maintaining the structural components and mechanical systems.

f. A requirement to contact the appropriate regulatory authority for approval prior to storing any off-farm waste material in a waste storage facility that has been constructed using the criteria in this standard.

g. A contingency plan, which shall be implemented when the maximum operating level is reached. The contingency plan shall include how to handle unexpected volumes of wastewater and/or runoff that could cause the system to overflow before scheduled emptying can occur. The contingency plan shall provide for the safe disposition of waste.

h. An emergency response plan to deal with failures, spills, or overflows at the animal production area to minimize environmental impacts.

i. Safety issues and procedures/requirements connected with waste storage facilities, including confined spaces.

15. Seeding and Mulching

Disturbed areas and embankments shall be seeded and mulched in accordance with WI FOTG Standard 342, Critical Area Planting.

B. Specific Criteria for Waste Storage Impoundments and Structures

Waste Storage impoundments and structures shall be designed to contain all wastes until emptied and utilized in accordance with the Operation and Maintenance Plan. The storage facilities may be used alone or in combination to contain the various waste streams. There shall be no gravity outlets from the waste storage as a means of emptying the facility. Flow from an auxiliary spillway must discharge to secondary containment. Gravity flow between waste storage facilities is acceptable, however a secondary containment or additional storage capacity must be provided for the potential waste volume release. The following specific criteria apply to this practice:

1. Concrete Liners

Floors and slabs-used as a liner shall be designed for anticipated loads along with crack control and joint treatments stated below. Slabs on ground that will be subject to heavy truck or heavy equipment loads shall be designed in accordance with ACI 360, Guide to Design of Slabs-on-Ground and Concrete Floors on Ground, Chapter 5, Portland Cement Association (PCA).

a. Concrete with waterstop – The concrete shall contain distributed reinforcing steel, and all joints shall have embedded waterstop in accordance with Wisconsin FOTG Construction Specification 4, Concrete (Spec. 4).

A waterstop joint plan shall be included in the construction plans and contain the following: location of joints; cross-section details of joint(s); waterstop materials including factory fabricated corners, intersections, and transitions; installation specifications; and a quality assurance plan.

Construction quality assurance requirements for waterstop installation shall, at a minimum, include verification and documentation of the adequacy of the formwork, waterstop placement and welding prior to placement of the concrete, and continuous inspection during placement of concrete around embedded waterstop to ensure consolidation. The inspection shall be performed by a person under the direction and control of the individual responsible for approving the as-built construction plan. The person providing the inspection may not be an employee of the contractor or the owner.

A concrete mix in accordance with WI Spec. 4 shall be used.

Floors and slabs shall contain temperature and shrinkage reinforcing steel equal to or greater than shown in Table A. Steel shall be placed in the top ½ of the slab thickness with a minimum clear distance from the top of the slab of 1.5 inches.

Additional waterstop *control joints* shall be planned where stresses can be predicted to exceed the reinforcing steel's ability to restrain cracking and minimize leakage.

All waterstop joints in areas subject to equipment traffic shall be designed with a dowel system to transfer the load across the joint. Slab thickness changes at these joints shall be made with a minimum transition ratio of one inch of thickness change over ten inches of run (10:1).

Table A
Reinforcing Steel for Temperature and Shrinkage Control

Control Joint Spacing			
Concrete Thickness	**Rebar Size (grade 60) and Spacing**		
	≤ 100 ft.	≤ 150 ft.	≤ 175 ft.
≤ 5 "	#4 @ 18"	#4 @ 15"	#5 @ 18"
≤ 6 "	#4 @ 18"	#5 @ 18"	#5 @ 15"
≤ 7 "	#4 @ 15"	#5 @ 15"	#5 @ 12"
≤ 8 "	#5 @ 18"	#5 @ 15"	#5 @ 12"

b. Concrete soil composite – The concrete is in *intimate contact* with the soil and the concrete and soil work together to reduce seepage losses. Floors and slabs shall be a minimum of 5 inches thick with reinforcing consisting of #4 bars spaced at 18 inches on center each way. No control or *expansion joints* are required. The concrete shall be placed in intimate contact with the foundation soil. The reinforcing steel shall be continuous through all *construction joints.* Drain tile and/or drain fill material shall be kept outside of the soil component of the composite liner.

2. Impoundment Design Criteria

Soil criteria in Tables 1 through 5 refer to mineral soils. Construction shall not occur on or with organic soils.

Table 1 contains the criteria for constructing waste impoundments into existing soils with recompaction of the upper 1 foot of soil. Tables 2 through 5 contain the criteria for impoundments with liners.

A combination of liners is acceptable. There shall not be more than two liner types used in any one facility. The sump liner does not apply as a liner type in this regard. The liners shall be joined so as to preserve the performance and integrity of all liner types.

Concrete walls used within impoundments shall maintain the integrity of any liner.

Any penetration and overfall/outfalls of the liner shall be constructed to maintain the performance and integrity of the liner used.

Liners shall be designed to withstand all anticipated internal and external loads, and resist agitation scouring.

a. Embankment Requirements

1) The foundation area shall be stripped to remove vegetation and unsuitable materials.

2) A core trench shall be required whenever the settled embankment fill height at the centerline is ≥ 10 feet. Minimum dimensions of the core trench shall be 8-foot bottom width, 2-foot depth, and 1:1 or flatter side slopes.

3) Additional fill for settlement shall be a minimum of 5% of the fill height measured at the centerline.

4) After settlement, the top of the embankment shall be ≥ 1 foot above the surrounding grade. Any diversion along the embankment shall have a capacity for 25-year, 24-hour storm plus 0.5 feet of freeboard.

5) For liquid storage facilities with greater than one acre of surface area and where wave action is a concern, increase the embankment height to account for the calculated wave height, or provide other means to address the wave action concern.

6) The minimum top width shall be according to the table below.

Settled Embankment Fill Height (feet)	Top Width (feet)
0 - 10	≥ 8
10.1 - 15	≥ 10
15.1 - 20	≥ 15
20.1 - 25	≥ 20

7) The sum of interior and exterior side slopes shall be ≥ 5:1 with no slope steeper than 2:1. All slopes must be stable. Additional embankment requirements are contained in the tables.

8) Compaction shall be according to WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities (Spec. 204).

Table 1 - *In-Place Earth* Criteria for Impoundments 20 Feet Deep or Less [Note 1]

1. Size			
Design Storage Volume		≤ 300,000 cu. ft.	> 300,000 cu. ft.
Manure Produced at Farm per Year		≤ 600,000 cu. ft.	> 600,000 cu. ft.
Waste Characteristics		≥ 4% manure solids in stored waste, ruminant animals only	All
2. Soils [Note 2]			
% Fines		≥ 40%	≥ 40%
Plasticity Index (PI)		≥ 7	≥ 12
Total Thickness, (measured perpendicular to storage surface, includes thickness of recompacted layer)		≥ 5 ft.	≥ 5 ft.
Thickness of Recompacted layer (upper 1' of soil)		≥ 1 ft.	≥ 1 ft.
Construction Specification (for recompacted 1' layer)		WI Spec 204[Note 4]	WI Spec 300[Note 5]
3. Separation Distances			
- Well Distance [Note 3]		≥ 250 ft.	≥ 250 ft.
- Sinkholes		≥ 800 ft.	≥ 400 ft.
- Subsurface Saturation (V.A.9)		≥ 6 ft.	≥ 6 ft.
- Bedrock		≥ 6 ft.	≥ 6ft.
4. Impoundment			
Inside Slope		2.5:1 or flatter	
Embankment		Shall be constructed with material meeting criteria in Table 1 from the inside surface to the embankment centerline, in accordance with the applicable compaction specification for the recompacted 1' layer.	
5. Other			
Scour Protection	Agitation and Pumping Locations	Minimum 20 ft. wide x 30 ft. long x 4 in. thick concrete pad or sump in bottom and 20 ft. wide ramp or a 16 ft. wide ramp with 12 in. high curbs to the top of the facility.	
	Scraping and Other Mechanical Means of Removing Solids and Sand	Protect with hard surfacing designed for the expected conditions and loads, a minimum of 4 in. thick.	
Existing Field Drain Tile		Additional site investigation shall be completed to determine the presence of existing field drain tile within 100 ft. of the footprint of the facility. Any tile found must be abandoned or removed.	

Note 1 The depth is measured from the bottom of the impoundment to the maximum operating level.

Note 2 Soil tests shall be completed in a laboratory on representative samples of soil beneath the proposed liner grade at a rate of 1 test per 15,000 ft^2 of facility footprint, with a minimum of two tests. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 Community water system wells may require larger separation distances (see NR 811).

Note 4 WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities.

Note 5 WI FOTG Construction Specification 300, Clay Liner;

Table 2 - Clay Liner Criteria for Impoundments

1. Size		
Design Storage Volume	≤ 300,000 cu. ft.	> 300,000 cu. ft. [Note 1]
Manure Produced at Farm Per Year	≤ 600,000 cu. ft.	> 600,000 cu. ft.
2. Clay Liner Requirements		
Thickness, Bottom	≥ 3 ft.	As specified in Table 2A
Thickness, Sides	≥ 5 ft.	≥ 5 ft.
% Fines [Note 2]	≥ 50%	≥ 50%
Plasticity Index (PI) [Note 2]	≥ 12	≥ 12
Permeability, cm/sec. [Note 3]	—	≤ $1x10^{-7}$
Construction Specification	WI Spec 204 [Note 4]	WI Spec 300 [Note 5]
3. Separation Distances		
Wells [Note 6]	≥ 250 ft.	≥ 250 ft.
Sinkholes	≥ 400 ft.	≥ 400 ft.
Subsurface Saturation (V.A.9)	≥ 4 ft.	As specified in Table 2A
Bedrock	≥ 4 ft.	As specified in Table 2A
4. Other		
Liner Protection Required		
Agitation and Pumping Locations	Minimum 20 ft. wide x 30 ft. long x 4 in. thick concrete pad or sump in bottom and 20 ft. wide ramp or a 16 ft. wide ramp with 12 in. high curbs to the top of the facility.	
Scraping and Other Mechanical Means of Removing Solids and Sand	Protect with hard surfacing designed for the expected conditions and loads, a minimum of 4 in. thick.	

[Note 1] These two columns show the minimum criteria for larger storage facilities and farms, but can also be used for smaller facilities and farms.

[Note 2] The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

[Note 3] Permeability shall be determined by ASTM D5084 from undisturbed samples of the compacted liner.

[Note 4] WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities.

[Note 5] WI FOTG Construction Specification 300, Clay Liner.

[Note 6] Community water system wells may require larger separation distances (see NR 811).

Table 2A – Clay Liner Thickness [Note 1] (Bottom) and Separations

Impoundment Depth [Note 2] (feet)	Liner Thickness (feet)	Separation to Subsurface Saturation and Bedrock (feet)
0 – 13	≥ 3.0	≥ 4.0
13.1 – 14	≥ 3.2	≥ 4.2
14.1 – 16	≥ 3.6	≥ 4.6
16.1 – 18	≥ 4.1	≥ 5.1
18.1 – 20	≥ 4.5	≥ 5.5
20.1 – 22	≥ 5.0	≥ 6.0
22.1 – 24	≥ 5.4	≥ 6.4
24.1 - 25	≥ 5.7	≥ 6.7

[Note 1] Thickness is calculated based on a maximum permeability of $1x10^{-7}$ cm/sec and a specific discharge limit of 500 gallons/acre/day using Darcy's Law.

[Note 2] Depth is the distance from the bottom of the impoundment up to the maximum operating level (M.O.L.).

Table 3 - *Geomembrane* Liner Criteria for Impoundments

1. Liner Material			
		60 mil High Density Polyethylene (HDPE) or 60 mil Linear Low Density Polyethylene (LLDPE) or 60 mil Ethylene Propylene Diene Monomer (EPDM). The geomembrane shall be installed with intimate contact to the soil below [Note 1]	
2. Soils (Directly Below Liner)[Note 2]			
% Fines		≥ 40%	≥ 40%
Plasticity Index (PI)		≥ 7	—
Thickness		≥ 2 ft.	≥ 4 ft.
Compaction of Placed Material		WI Spec 204[Note 3]	WI Spec 204[Note 3]
Subgrade preparation requirements		WI Spec 202 or 205[Note 4]	WI Spec 202 or 205[Note 4]
3. Separation Distances			
Well Distance [Note 5]		≥ 250 ft.	≥ 250 ft.
Sinkholes		≥ 400 ft.	≥ 400 ft.
Subsurface Saturation (V.A.9)		≥ 4 ft.	≥ 6 ft.
Bedrock		≥ 4 ft.	≥ 6 ft.
4. Impoundment			
Inside Slope		2.5:1 or flatter.	
5. Other			
Liner Protection Required	Agitation and pumping locations[Note 6]	Minimum dimension of 20 ft. wide x 30 ft. long concrete pad or sump in bottom and 20 ft. wide ramp with 18 in. curb to the top of the facility with provisions for liner integrity. Ramps shall be located to be accessible to the agitation equipment used.	
	Scraping and other mechanical means of removing solids and sand [Note 7]	Protect with hard surfacing designed for the expected conditions and loads.	
Vent system		Required for all facilities. The system shall be designed in such a manner to vent gas from the system. Waste and runoff shall be prevented from entering the venting system. Liquid detection points may be installed as part of the system.[Note 1]	
Liner Installation		• Continuous Inspection Required • All geomembrane placement, seaming, seam testing, and repair and concrete placement for liner protection shall be completed under the continuous observation of a qualified third-party quality assurance inspector under the direction of a Professional Engineer. This inspector shall not be an employee of the contractor, owner, or geomembrane supplier.	

Note 1 Intimate contact does not exclude the use of gravel trenches for gas venting or monitoring systems.

Note 2 The liner is in intimate contact with the soil, and the two work together to reduce seepage losses. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 WI FOTG Construction Specification 204, Earthfill for Waste Storage Facilities.

Note 4 WI FOTG Construction Specification 202, Polyethylene Geomembrane Lining and 205, Ethyl Propylene Diene Monomer (EPDM) Geomembrane Lining.

Note 5 Community water system wells may require larger separation distances (see NR 811).

Note 6 Poured-in-place concrete slabs shall meet requirements of Table 5, Note 2 if the geomembrane will be joined to the liquid-tight concrete. All connections between the geomembrane and concrete shall be liquid tight and structurally sound. If the liner protection is placed on top of the geomembrane, it shall be structurally sound, but liquid-tightness is not required. Liner protection poured on top of the geomembrane shall be separated from the geomembrane by a sacrificial layer of the same weight geomembrane and a cushioning layer of 12 oz/sy non-woven geotextile. The sacrificial layer shall not be welded to the geomembrane liner. Liner protection installation over the geomembrane shall be completed by methods that will maintain the integrity and performance of the liner. Liner protection placed on slopes shall be designed with provisions to ensure stability.

Note 7 Sand bedding may be used in conjunction with a geomembrane liner, but the design must include a method to remove sand from the waste stream before it enters the waste storage facility.

Table 4 - *Geosynthetic Clay Liner (GCL)* Criteria for Impoundments

1a. Soils (Directly Below Liner) [Note 1]			
% Fines		≥ 20%	≥ 20%
Plasticity Index (PI)		≥ 7	—
Thickness (from bottom and sides)		≥ 2 ft.	≥ 3 ft.
Compaction of placed material		WI Spec 203 [Note 2]	WI Spec 203 [Note 2]
1b. Liner Cover Material Thickness			
Bottom		≥ 1 ft.	≥ 1 ft.
Side Slopes		≥ 2 ft.	≥ 2 ft.
Compaction of Placed Materials		WI Spec 203 [Note 2]	WI Spec 203 [Note 2]
2. Separation Distances			
Well Distance [Note 3]		≥ 250 ft.	≥ 250 ft.
Sinkholes		≥ 400 ft.	≥ 400 ft.
Subsurface Saturation (V.A.9)		≥ 4 ft.	≥ 5 ft.
Bedrock		≥ 4 ft.	≥ 5 ft.
3. Impoundment			
Inside Slope [Note 4]		3:1 or flatter	
4. Other			
Liner Protection	Agitation and Pumping Locations	Minimum dimension of 20 ft. wide x 30 ft. long x 4 in. thick concrete pad or sump in bottom and 20 ft. wide ramp or a 16 ft. wide ramp with 18 in. high curb to top of facility. GCL continues under the concrete pad or sump. Poured in place concrete slabs shall meet requirements of Section V.B.1.	
	- Scraping and Other Mechanical Means of Removing Solids and Sand	Sand bedding may be used in conjunction with a geosynthetic clay liner, but the design must include a method to remove sand from the waste stream before the waste is stored in the liner or the liner must be protected to allow mechanical removal of the sand. Poured in place concrete slabs shall meet requirements of Section V.B.1.	
GCL Material [Note 5]		Non-woven needle punched.	

[Note 1] The liner is in intimate contact with the soil, and the two work together to reduce seepage losses. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

[Note 2] WI FOTG Construction Specification 203, Geosynthetic Clay Liner.

[Note 3] Community water system wells may require larger separation distances (see NR 811).

[Note 4] The GCL and soil cover shall be stable at the designed side slope.

[Note 5] The liner shall be installed according to manufacturer's specifications and WI FOTG Construction Specification 203, Geosynthetic Clay Liner.

Table 5 - Concrete Liner Criteria for Impoundments

	Concrete with Waterstop [Note 1]	Concrete - Soil Composite [Note 2]			
1. Soils (Directly Below Liner) [Note 2]					
% Fines	—	≥ 20%	≥ 20%	≥ 40%	Foundry Sand [Note 5]
Plasticity Index (PI)	—	≥ 7	—	≥ 12	—
Thickness (bottom and sides)	—	≥ 1.5 ft.	≥ 3 ft.	≥ 8 Inches	≥ 1.5 ft.
Compaction of Placed Material	WI Spec 204	WI Spec 204	WI Spec 204	WI Spec 300	WI Spec 204
2. Separation Distances [Note 6]					
Sinkholes Well Distance [Notes 3 and 4]	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.	≥ 400 ft. ≥ 100 ft.
Subsurface Saturation (V.A.9)	≥ 2 ft. (1 ft. for sump)	≥ 4 ft. (3 ft. for sump)	≥ 5 ft. (4 ft. for sump)	≥ 3 ft. (2 ft. for sump)	≥ 4 ft. (3 ft. for sump)
Bedrock	≥ 2 ft. (1 ft. for sump)	≥ 4 ft. (3 ft. for sump)	≥ 5 ft. (4 ft. for sump)	≥ 3 ft. (2 ft. for sump)	≥ 4 ft. (3 ft. for sump)
3. Impoundment					
Inside Side Slopes	2.5:1 or flatter	2:1 or flatter			

Note 1 Refer to section V.B.1.a. for design criteria specific to concrete with waterstop.

Note 2 Refer to section V.B.1.b. for design criteria specific to concrete composite liners. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 3 Community water system wells may require larger separation distances (see NR 811)

Note 4 For operations subject to NR 243, the private or non-community Well Separation Distance is 250 ft.

Note 5 The foundry sand must be ferrous foundry sand with only minimal concentrations of hazardous constituents, cores and other over-size materials crushed or removed, and at least 5% bentonite content. A site specific WDNR approval is required under NR 538 that may specify greater separation distances and parameters not addressed by this standard. An NR 538 Category I or II ferrous foundry sand may be appropriate.

Note 6 Lesser separation distances shown for sumps apply only when the total sump area is less than 15% of the floor footprint area of the waste storage facility.

3. Structure Design Criteria

The structure design shall include all items that will influence the performance of the structure, including loading assumptions, material properties, construction quality, waterstops, pipe penetrations, anchor plates, or other attachments to walls such as fence posts. Design assumptions and construction requirements shall be indicated on the construction plans. Waste storage structure separation criteria shall be as shown in Table 6. Any penetration of the structure shall be constructed to maintain the performance and integrity of the structure.

Table 6
Waste Storage Structure Separation Distances

Well Distance[Note 1]	≥ 100 ft.
Sinkholes	
Storage floor above ground	≥ 200 ft.
Storage floor below ground	≥ 400 ft.
Subsurface Saturation and Bedrock	See Table 5

Note 1 For operations subject to NR 243, the private or non-community well separation distances is 250 feet, community water system wells may require larger separation distances (see NR 811).

Structures may be designed with or without covers. Covers, beams, or braces that are integral to structural performance shall be designed accordingly and indicated on the construction drawings. The openings in covered structures 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.

a. Fabricated Structures - Fabricated structures shall be designed according to the following criteria:

(1) Steel. "Manual of Steel Construction," American Institute of Steel Construction.

(2) Timber. "National Design Specifications for Wood Construction," American Forest and Paper Association.

(3) Concrete. "Building Code Requirements for Reinforced Concrete, ACI 318," American Concrete Institute. Concrete design calculations shall use a minimum design compressive strength of 3,500 psi.

b. Foundations - 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 shall 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 7 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.

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

If a dense ice cover can be expected the designer shall account for the additional point load associated with an ice sheet against a vertical wall.

Where the stored waste is not protected from precipitation, use 65 $lb/ft^2/ft$ of depth as the design internal lateral pressure. Use an internal lateral pressure of 72 $lb/ft^2/ft$ of depth for sand-laden manure. 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.

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 NRCS Technical Release 74, Lateral Earth Pressures. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 8 shall be used.

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

1) Rigid frame or restrained wall. Use the values shown in Table 8 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 8 under the column "Free Standing 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 ratio not more than 0.085.

   If heavy equipment will be operated near the wall, an additional surcharge equivalent to two feet of soil shall be applied in the wall analysis.

   Structures 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 is to have a roof, snow and wind loads shall be as specified in ASCE SEI/ASCE 7-10, 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.

d. Concrete Joints

   Wall Joints – Cast-in-place vertical walls shall have one control joint with embedded waterstop every 100 feet with a minimum of two control joints per four-sided structure. Vertical wall control joints are not required in structures with less than 100 feet of wall length.

   Waterstop shall be embedded or expansive in accordance with WI Spec. 4. The type of waterstop is based on the joint movement criterion indicated below.

   If there is no embedded waterstop at the wall base, the wall joint waterstop shall be cast 4 inches into the footing. If there is an embedded waterstop between the footing and the bottom of the wall, the wall joint waterstop shall be welded to a factory fabricated intersection at the base of the wall.

   An embedded waterstop shall be installed at the wall to footing intersection if the joint is designed for movement. Either an expansive or embedded waterstop shall be installed at this joint if it is not designed for movement (fixed).

   Joints for pre-cast walls shall demonstrate evidence of equivalent performance to waterstop joints as determined by the NRCS State Conservation Engineer.

   Floor Joints – Floor joints in vertical walled structures, if used, shall extend through the footing and continue to the top of the vertical wall. Joints shall meet the requirements of section V.B.1. of this standard.

   Transitions from concrete wall footings to concrete slabs shall be made at a ratio of one inch of thickness change to one inch of run (1:1) or flatter.

Table 7 – Presumptive Allowable Bearing Stress Values [Note 1]

Class of Materials	Allowable Foundation Pressure (psf)
Crystalline Bedrock	12,000
Sedimentary and Foliated Rock	4,000
Sandy Gravel or Gravel (GW and GP)	3,000
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, Sandy Clay, Silty Clay, Clayey Silt, Silt and Sandy Silt (CL, ML, MH and CH)	1,500

Note 1 International Building Code (IBC), 2006, International Code Council (ICC)

Table 8 - Lateral Earth Pressure Values [Note 1]

Soil		Equivalent Fluid Pressure (lbs./sq. ft./per ft. of depth)			
		Above Water Table		Below Water Table [Note 3]	
Description	Unified Classification [Note 2]	Free Standing Wall	Frame Tanks	Free Standing Wall	Frame Tanks
- Clean gravel, sand or sand-gravel mixtures (maximum 5% fines)[Note 4]	GP, GW, SP, SW	30	50	80	90
- Gravel, sand, silt and clay mixtures (< 50% fines) - Coarse sands with silt and/or clay (<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% fines) - Fine sands with silt and/or clay (< 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% fines)	CL, ML, CL-ML	65	85	95	110
- High plasticity silts and clays (liquid limit more than 50)[Note 5]	CH, MH	–	–	–	–

Note 1 For lightly compacted soils (85% to 95% maximum standard density). Includes compaction by use of typical farm equipment.

Note 2 All definitions and procedures in accordance with ASTM D2488 and D653.

Note 3 Includes hydrostatic pressure from subsurface saturation.

Note 4 Generally, only washed materials are in this category.

Note 5 Not recommended. Requires special design if used, see the companion documents in Chapter 10 AWMFH.

C. Specific Criteria for Permanent Stacking Facilities at the Animal Production Area

This criteria does not apply to the unstacked wastes that accumulate in animal housing units.

This criteria applies to stacking the following materials in a confined manner at the animal production area:

- Separated manure solids
- Compost
- Dewatered, recycled sand storage
- Poultry litter (turkey or broiler operations)
- Dry poultry layer manure
- Bedded manure (>50% solids)
- Waste feed (<50% moisture)

Facilities must be designed to prevent run-on and runoff, and operated to prevent ponding and significant hydrostatic head. Facilities may commonly be located near the ground surface, but may be above or below ground. Criteria for stacking facilities are shown in Table 9. **Solids stacking within the animal production area may also be done in an impoundment (Tables 1 through 5) or section V. B. 3.** Methods to ensure ongoing compliance with the criteria must be incorporated into the Operation and Maintenance Plan.

Table 9 – Liner Criteria for Permanent Solids Stacking Facilities at the Animal Production Area Note 1

	Roofed		Not Roofed Note 2	
	Work Surface Note 3	No Surface Note 4	Work Surface Note 3	No Surface Note 4
1. Soils In-Place Liner Note 4				
% Fines	≥ 30%	≥ 30%	≥ 40%	≥ 40%
Plasticity index (PI)	-	≥ 7	-	≥ 7
Thickness	≥ 2 ft.	≥ 2.5 ft.	≥ 3 ft.	≥ 5 ft.
2. Soils Compacted Liner Note 4				
% Fines	≥ 30%	≥ 40%	≥ 40%	≥ 40%
Plasticity index (PI)	≥ 5	≥ 7	≥ 7	≥ 7
Thickness	≥ 1.5 ft.	≥ 2 ft.	≥ 2 ft.	≥ 3 ft.
Compaction	WI Spec 204	WI Spec 204	WI Spec 204	WI Spec 204
3. Separation Distances				
Sinkholes	≥ 400 ft.	≥ 400 ft.	≥ 400 ft.	≥ 400 ft.
Well distance Note 5	≥ 100 ft.	≥ 100 ft.	≥ 100 ft.	≥ 100 ft.
Subsurface Saturation	≥ 3 ft.	≥ 3 ft.	≥ 5 ft.	≥ 5 ft.
Bedrock	≥ 3 ft.	≥ 3 ft.	≥ 5 ft.	≥ 5 ft.
4. Stacking Area	Stacking area not to exceed 7 acres for unroofed managed compost, 2 acres for sand, 2 acres for roofed facilities, or 1 acre for all other materials.			

Note 1 Solids and sand stacking facilities, treatment areas and other production area structures and systems may be subject to surface water setbacks and other requirements under state and local rules. MOL requirements do not apply to this Table.

Note 2 Facilities that are not roofed must have floors sloped to control surface drainage; and, unless used only for properly managed composting, all leachate and runoff (up to the 25-yr., 24-hr. storm) must be managed as follows:

Collect leachate and runoff in a facility suitable for liquid containment (Tables 1 through 6) or transfer receptacle (WI FOTG Standard 634), until land applied in accordance with WI FOTG Standard 590, or provide other acceptable treatment for runoff only. Acceptable treatment methods for runoff may only include those described in WI FOTG Standard 635 or WI FOTG Standard 629.

Note 3 The work surface may be constructed of any of the following: minimum 3 in. for asphalt; minimum 4 in. for concrete; or minimum 8 in. for macadam, and designed for anticipated equipment loads. Refer to industry standard design criteria for each work surface material. The purpose of the work surface is to protect the liner material.

Note 4 Facilities without a work surface must be operated to minimize rutting and removal of the soil liner. Ruts must be repaired and the soil liner thickness maintained after material handling. Stacking height is not to exceed 10 ft. The PI shall be determined in accordance with ASTM D4318 and the percent fines in accordance with ASTM D1140.

Note 5 Additional separation distances to wells may be necessary on WDNR regulated farms.

D. **Specific Criteria For Temporary, Unconfined Stacks of Manure and Derivatives Outside the Animal Production Area**

This includes solid type manure and derivatives that are deposited for subsequent loading and spreading. Waste material having less than 16% solids shall not be stacked in the field. Storage of these materials shall be in facilities meeting the criteria in section V.B.1 and 2. Criteria for unconfined waste stacks are shown in Table 10.

Conservation BMPs shall be used above stacking sites to divert overland flow, and below stacking sites to provide containment or buffering to downstream channels and lakes.

The maximum amount of manure that is stacked on any one field shall be limited to the nutrient needs of fields adjacent to the stacking site in accordance with a 590 nutrient management plan.

Table 10 – Temporary, Unconfined Stacks of Manure and Derivatives Outside the Animal Production Area

1. Waste Consistencies Note 1		
	> 32% Solids	16% to 32% Solids Note 2
2. Size & Stacking Period		
Stacking Period	8 months	8 months
Maximum Volume/Stack	≤ 40,000 cu ft.	≤ 15,000 cu ft.
Maximum Number of Stacks/40 acres Note 3	–	2
Frequency of Stacking Site Use	1 year out of 2	1 year out of 3
3. *Hydrologic Soil Groups*		
	B or C	B or C
4. Subsurface Separation Distance		
Subsurface Saturation	≥ 3 ft.	≥ 3 ft.
Bedrock	≥ 3 ft.	≥ 5 ft.
5. Surface Separation Distance		
Wells Note 4	≥ 250 ft.	≥ 250 ft.
Lakes	≥ 1,000 ft.	≥ 1,000 ft.
Sinkholes, or other Karst Features	≥ 1,000 ft.	≥ 1,000 ft.
Quarries	≥ 1,000 ft.	≥ 1,000 ft.
Streams	≥ 300 ft.	≥ 500 ft.
Wetlands and Surface Inlets	≥ 300 ft.	≥ 500 ft.
Areas of Concentrated Flow	≥ 100 ft.	≥ 300 ft.
Land Slope Down Gradient of Stack	≤ 6%	≤ 3%
Floodplain	≥ 100 ft.	≥ 300 ft.
Tile lines	≥ 40 ft.	≥ 40 ft.

Note 1 Refer to AWMFH, Figure 9-1 for consistency values and Chapter 4 for % solids, for specific livestock types.

Note 2 16% to 32% solids represents waste at near saturation conditions where additions of free water from runoff, rain, or snowmelt can result in liquid flow conditions.

Note 3 The separation distance between stacks shall be at least 100 feet.

Note 4 Community water system wells may require larger separation distances (see NR 812).

VI. Considerations

Additional recommendations relating to design which may enhance the use of, or avoid problems with, this practice, but are not required to ensure its basic conservation function are as follows:

A. Consider using the companion documents located in Chapter 10 of the NRCS, Agriculture Waste Management Field Handbook (AWMFH).

B. Consider using the Waste Storage Design spreadsheet located in Chapter 10 of the NRCS AWMFH for design storage volume, liner thicknesses, and other calculations described in this standard.

C. Implementing erosion control methods on the top half of the inside slopes of earthen impoundments may reduce erosion.

D. Adding an auxiliary spillway, additional embankment height, or both may be needed to help protect the embankment, particularly for systems that store large volumes of runoff. Factors such as downstream hazards and receiving waters should be evaluated in this consideration. Locate the auxiliary spillway to direct waste overflows away from receiving waters or sensitive areas. See Consideration N below for more ways to address environmental concerns.

E. Non-polluted runoff should be excluded except where its storage is advantageous.

F. Separating solids from waste entering waste storage facilities may minimize the frequency of accumulated solid removal and benefit the pumping and application of the stored waste; however, this may increase odors.

G. Consider outletting drainage systems to locations that will not directly enter surface water.

H. Adding or including steel reinforcement in slabs that will be scraped may prevent vertical displacement at crack locations.

I. Consider placing a permanent marker at the level one-foot below the top of the storage facility and a marker to designate the empty level. This consideration is particularly important for operations considering future herd expansion to WPDES permit size.

J. Monitoring and leakage collection systems should be considered for larger waste storage facilities, especially where the site assessment indicates the area is sensitive for groundwater impacts. This is particularly important for operations considering future expansion to WPDES permit size. Components of a designed system may include secondary containment (soil or synthetic), leachate collection, leachate recirculation, monitoring sumps, and/or monitoring wells. See NR 141 for regulations concerning monitoring wells.

K. Composting should be done in accordance with guidance from books such as “On-Farm Composting Handbook,” NRAES-54, or equivalent.

L. Avoid locating facilities in areas where negative impacts to water resources may occur, particularly near streams or in floodplains.

M. Consider incorporating the following practices into the waste management system to reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

- National Handbook of Conservation Practices (NHCP), Standards 366, Anaerobic Digestion-Controlled Temperature; 367, Waste Storage Cover; and 317, Composting Facility;
- Siting of livestock housing or feedlots, manure storage, and land application;
- Biofilters;
- Feed ration additives and adjustments;
- Manure additives, disinfectants, or aeration;
- Incorporation of manure when land-applied;
- Moisture and dust control within livestock housing areas; and
- Dead animal disposal plans.

For additional information on odor abatement see: ASAE EP379.4 Jan. 2007, Management of Manure Odors.

N. The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments:

- Storage for wet-year rather than normal-year precipitation,
- Reinforced embankment, such as additional top width, flattened and/or armored downstream side slopes, and
- Secondary containment.

O. When designing impoundment embankments, consider using flatter slopes on the outside embankment slope. This would provide better operation access and easier maintenance of the impoundment (i.e., pumping equipment access, mowing, and removal of woody vegetation.)

P. As-Built Plans and other certification (attesting) documentation, a required element of a Construction Inspection Plan, is normally required to be submitted to the permitting or cost-sharing authorities prior to placing the waste storage facility in service.

Q. Consider designing a waste storage facility to contain more than the 25-year, 24-hour rainfall event if: due to site conditions, a rainfall event greater than the 25-year, 24-hour storm is likely to cause a significant discharge to surface water; or the operation will become a permitted CAFO and it houses swine, poultry or veal calves, and the waste storage facility will be uncovered.

R. Well construction logs within ½ mile of the proposed facility, available from the Wisconsin Geologic and Natural History Survey and/or the Wisconsin Department of Natural Resources may be included to promote understanding of water supply aquifers in the area along with area hydrogeology.

S. Consider increasing the horizontal reinforcement ratio beyond the minimum required in ACI 318 for vertical crack control in concrete walls.

T. A secondary liner directly below concrete joints with waterstops should be considered where the site assessment indicates the area is sensitive to leakage impacts.

VII. References

American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures, SEI/ASCE 7-10.

American Society of Agricultural and Biological Engineers (ASABE), Standards EP378.3, EP393.2, EP379.4, and EP470.

American Society of Testing Materials (ASTM) D1140, D4318, D5084, D2488, and D653.

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

Manual of Steel Construction, American Institute of Steel Construction.

National Design Specifications for Wood Construction, American Forest and Paper Association.

Northeast Regional Agricultural Engineering Service, NRAES-54, On-Farm Composting Handbook, June 1992.

USDA, NRCS, Agricultural Waste Management Field Handbook, Part 651, 1992.

USDA, NRCS, National Handbook of Conservation Practices.

USDA, NRCS, Technical Release 74, Lateral Earth Pressures.

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

Wisconsin Administrative Code, Department of Natural Resources, Chapters NR 141, NR 243 and NR 812.

VIII. Definitions

% Fines (Table 1) – Percentage of given sample of soil which passes through a #200 sieve.

Animal Production Area (V.A.1.) – Means any part of the livestock operation that is used for the feeding and housing of livestock. This includes the entire animal confinement and feeding area, and any adjacent manure storage areas, raw materials storage areas, and waste containment areas. This does not include pasture and cropland.

Bedrock (V.A.2.b.1)) – The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

Note: Although solid or consolidated bedrock can sometimes be removed with typical excavation equipment, these materials are included in the above definition.

Confined Space (V.A.10) – Confined Space is a space that 1) contains or has the potential to contain a hazardous atmosphere; 2) is large enough and so configured that a person can bodily enter; 3) has limited or restricted means for entry or exit; and 4) is not designed for continuous human occupancy.

Construction Joint (V.B.1.b.) – These joints are used where a fresh pour of concrete abuts an existing recent pour. Construction joints where the steel is continuous through the joint are considered to be monolithic and liquid tight, if constructed properly.

Contaminated Runoff (II) – Runoff that has come through or across a barnyard or animal lot or feed storage area. It generally includes the runoff and any manure, sediment, feed, or other material carried in the runoff. It contains lower concentrations of contaminants than leachate from feed or manure.

Control Joints (V.B.1.a.) – Control joints, often called contraction joints, are used to control the location of cracks caused by concrete shrinkage during setting and thermal changes. Steel reinforcement is interrupted in control joints with embedded waterstop.

Cultural Resources (V.A.2.a.) – Cultural resources are the traces of any past activities and accomplishments of people. They include tangible traces such as historic districts, sites, buildings, structures, historical documents and cemeteries. They also include traces of less tangible objects such as dance forms, aspects of folk-life, cultural or religious practices, and some landscapes and vistas.

Drainage System (V.A.9.c.) – Water conveyance measures of specified capacity, location, and material that insure the removal of water to a free outlet.

Effective Height (III) – Height from the settled top of the embankment to the lowest point of the existing ground surface, measured at the centerline.

Expansion Joints – (V.B.1.b.) – These joints are used to prevent crushing of abutting concrete or other structural units due to compressive forces developed during expansion caused by high temperature.

Flood Prone Areas (V.A.3.) – These include areas delineated as floodplains on Federal Emergency Management Agency (FEMA) maps, or local floodplain maps as well as areas along perennial streams (blue lines) shown on the United States Geologic Survey quadrangle sheets that may be subject to out of bank flows.

Footprint (V.A.2.b.2)) – This is the horizontal area within the perimeter of a facility liner, or the perimeter of a work surface that may cover a liner. For a liquid or solids containment facility, the footprint is the maximum horizontal extent of containment. For a liquid impoundment facility or pond, the footprint is normally defined by the inside top of the embankment. For a solids storage facility, the footprint is normally defined by the edge of the pad, the curb on a pad, or the inside surface of bunker walls.

Geosynthetic Clay Liner, GCL (Table 4) – A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetic materials.

Geomembrane (Table 3) – Very low permeability synthetic membrane liner or barrier used with any geotechnical engineering related material so as to control fluid migration in a man-made project, structure or system. (ASTM D 4439)

Gleyed Soil (V.A.2.b.3)) – A soil condition resulting from prolonged soil saturation, which is manifested by the presence of bluish or greenish colors through the soil mass or in mottles (spots or streaks) among the colors. Gleying occurs under reducing conditions, by which iron is reduced predominantly to the ferrous state.

Hydrologic Soil Groups (Table 10) – Hydrologic Groups (HSG) are assigned for all soils mapped by USDA soil scientists. The hydrologic soil group, designated A, B, C, or D, indicates, in general, the amount of runoff to be expected from the soil after prolonged wetting. Soils in Group A yield very little runoff because they are rapidly permeable. Soils in Hydrologic Group D take water very slowly and yield large amounts of runoff. See Section II of the NRCS Wisconsin Field Office Technical Guide for HSG designations.

Impoundment (I) – A waste storage facility constructed of earthen embankments and/or excavations for the purpose of storing waste. An impoundment may be lined or unlined.

In-Place Earth (Table 1) – The entire surface of the bottom of the impoundment is excavated a minimum depth of one foot into the native soil.

Intimate Contact (V.B.1.b.) – Direct contact between liner materials (concrete, GCL, and geomembrane) and soil.

Karst (V.A.2.c.) – Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, disappearing streams, closed depressions, blind valleys, caves, and springs. See the companion document in Chapter 10 of the AWMFH for additional discussion of karst features.

Leachate (II) – Concentrated liquid waste which has percolated through or drained by gravity from a pile of

manure, manure processing derivative, or animal feed. It contains much higher concentrations of contaminants than Contaminated Runoff.

Manure Processing Derivatives (II) – The by-products and waste components that are produced as a result of treatment and processing practices. These include, but are not limited to, the following waste components: separated sand, separated manure solids, precipitated manure sludges, supernatants, digested liquids, composted biosolids, process waters.

Nutrient Management Plans (III) – A planning document that outlines the requirements for managing the amount, form, placement, and timing of applications of plant nutrients to cropland.

Perched Conditions (V.A.9.c.) – Perched conditions describe a soil moisture regime where saturated soil is located above unsaturated soil.

Permeability (Table 2) – The coefficient of permeability (K) is a measure of the ability of soil to transmit liquids. It is used to compute the flow rate of liquid through a soil liner for specific conditions of soil thickness and fluid head.

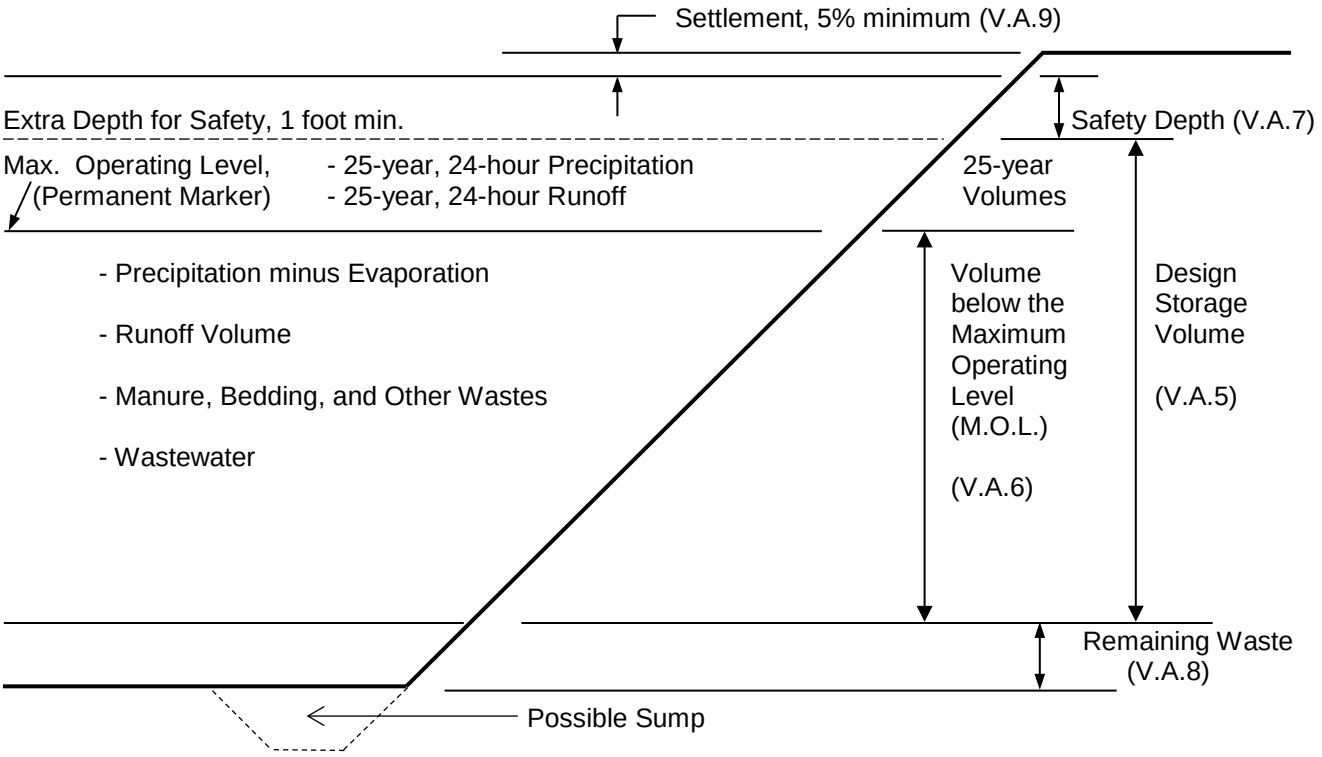
Plasticity Index, PI (Table 1) – A soil property indicating moldability. Measured by ASTM D4318.

Sinkholes (V.A.2.c) – Closed, usually circular depressions which form in karst areas. Sinkholes are formed by the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock.

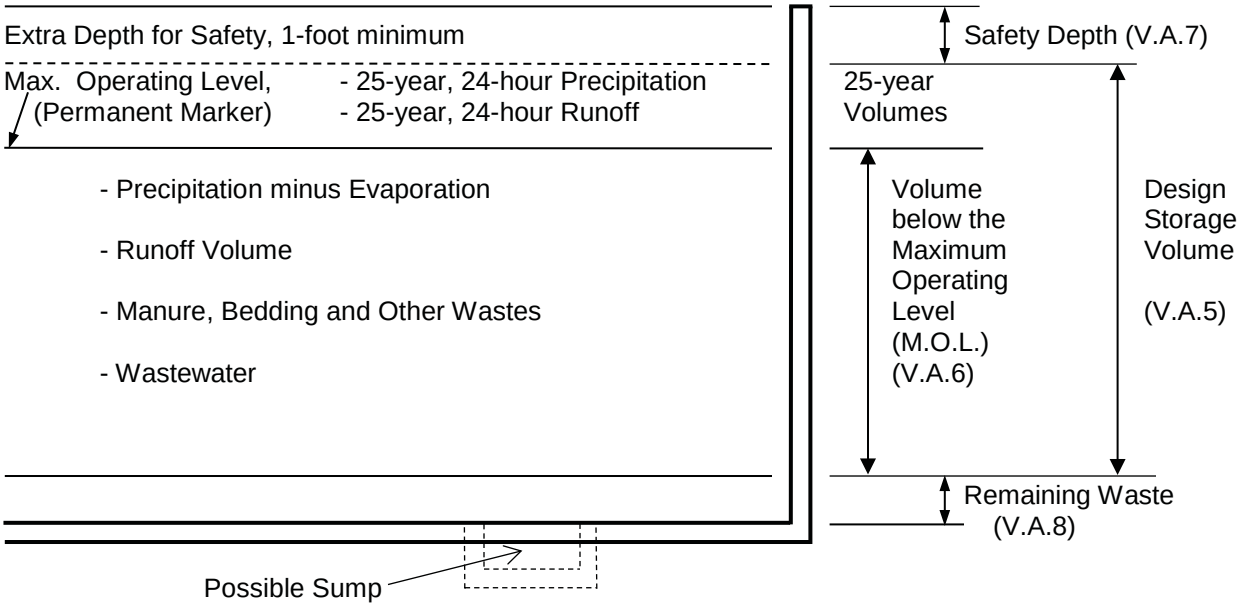
Structure (I) – A waste storage facility consisting of constructed surfaces, tanks, or walls for the purpose of storing waste above or below the ground surface. Structures may be constructed of concrete, steel, wood or other construction materials.

Wastewater (II) – Milking center waste, flush water, leachate from feed holding areas, and similar waste materials generated at the animal production area.

Figure 1
Design Storage Volume



IMPOUNDMENT



STRUCTURE

CRITICAL AREA PLANTING

(Acre)
Code 342

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal practices.

II. Purposes

This practice may be applied as part of a conservation management system to support one or more of the following purposes.

- Stabilize and restore riparian areas.
- Stabilize stream and channel banks and shorelines.
- Stabilize areas with existing or expected high rates of soil erosion by water or wind.
- Rehabilitate and revegetate degraded sites that cannot be stabilized using normal establishment techniques.

III. Conditions Where Practice Applies

This practice applies to highly disturbed areas such as:

- active or abandoned surface mine sites,
- urban conservation sites,
- road construction areas,
- conservation practice construction sites,
- areas needing stabilization before or after natural disasters such as floods, tornados, and wildfires,
- eroded banks of natural channels, banks of newly constructed channels, and lake shorelines, and
- areas degraded by human activities.

IV. Federal, Tribal, State and Local Laws

Critical area planting practices shall comply with all federal, tribal, state and local laws, rules or regulations. The landowner and/or operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state or local laws.

V. Criteria

A. General Criteria Applicable To All Purposes.

1. Site Assessment

   A site investigation shall be conducted to identify any physical, chemical, or biological conditions that could affect the successful establishment of vegetation. The site investigation shall include evaluation of: soil characteristics, soil fertility, slope, *aspect*[1], moisture regime, climatic patterns, proximity to natural plant community, and site history.

   Areas to be planted will be cleared of unwanted materials and smoothed or shaped, if needed, to meet planting and landscaping purposes.

   Compacted layers will be ripped and the soil re-firmed prior to seedbed preparation.

   On tilled or disturbed sites, prepare a firm seedbed. The seedbed shall contain enough fine particles for uniform shallow coverage of seed and contact with moisture and nutrients. For details on seedbed preparation, refer to Wisconsin Agronomy Technical Notes 5, Establishing and Maintaining Native Grasses, Legumes, and Forbs; and 6, Establishing and Maintaining Introduced Grasses and Legumes.

2. Specie Selection and Seed Quality

   Species selected for planting shall be suited to current site conditions, intended use, and be resistant to diseases and insects common to the site location.

[1]Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Selected species will have the capacity to achieve adequate density and vigor to stabilize the site within an appropriate period.

Native herbaceous or woody vegetation selected for planting shall be suitable for the site.

Species identified as restricted or prohibited by law shall not be planted.

Certified Seed shall be used, and seeding rates will be based on *Pure Live Seed* (PLS). Seed tag information such as purity and germination and any computations to adjust seeding rates must be submitted to document actual seeding rates. *Actual adjusted seeding rates* will be based on the equivalent of 100 percent PLS, determined by multiplying the percent purity by total percent germination.

Untested introduced and native grass and forb seed are not approved for planting.

When certified seed is unavailable or difficult to locate, *non-certified* seed can be used, after testing for varietal purity, germination, and other mechanical qualities, such as inert matter and other crop or weed seeds.

If more than 20 percent of legume seed is hard seed, increase the seeding rate for legumes by the percentage of hard seed.

Introduced and native legume seed shall be inoculated immediately prior to planting. Rhizobia inoculant shall be specific to the legume seeded. When more than one legume specie is used, each specie will be inoculated separately.

3. Seeding Periods

The specific date that provides the best chance for success will vary from south to north and from year to year with prevailing moisture and temperature conditions. Late summer seeding is generally riskier than spring seeding. Planting at either end of the allowable range is riskier than the middle of the range. Refer to Figure 1 for planting zones and Tables 1 and 2 for seeding dates.

Seeding outside of the recommended dates must be approved by the Area Resource Conservationist or State Agronomist.

Frost seeding is not an authorized seeding method when using this standard.

Dormant seeding can be used when planting introduced species. When using dormant seedings in concentrated flow areas, the site must be mulched according to the engineering design (if applicable) and Wisconsin NRCS Field Office Technical Guide, Section IV, (WI FOTG) Conservation Practice Standard 484, Mulching.

4. Nutrient and Soil Amendment Requirements

When seeding *introduced species*, soil fertility and pH level will be amended to satisfy the needs of the plant species to be established. Fertilizer and lime recommendations will be determined by a soil test, and all nutrients will be applied following WI FOTG Standard 590, Nutrient Management. If no soil test is available, apply a minimum of 150 pounds of 20-10-10 fertilizer and 2 tons of 80-89 lime or equivalent per acre. Soil amendments may be waived at the discretion of a certified conservation planner. The basis for waiving the use of soil amendments shall be documented in the client's case file.

For establishment of *native species*, use of soil amendments are not required.

5. Seedbed Preparation

Prior to planting into cropland fields, verify that herbicides previously applied to the site will not "carry over" and damage the new seeding.

Site preparation shall be adequate to assure weed suppression and to promote germination and growth of the species planted.

Planting equipment type, use, and timing shall be appropriate for the site conditions, soil characteristics, and type of seeds (size, etc.) selected to assure uniform placement and germination.

Refer to Wisconsin Agronomy Technical Notes 5 and 6 for detailed guidance for specific situations.

6. Mulching, Temporary Cover, and Companion Crop

Mulching, temporary cover, and companion crops are vital practices utilized to support the establishment of a critical area planting. Temporary cover and companion crops suppress weed growth and limit soil erosion during the establishment period. Use depends on the site conditions, method of planting, and seed mixture.

For further details on mulching, temporary cover and companion crop recommendations, refer to Wisconsin Agronomy Technical Notes 5 and 6.

B. Criteria for Seed Mixture Development

Seeding rates are based on seeds per square foot of Pure Live Seeds. Refer to Tables 3 and 4 for common species and seeding rates.

Additional approved species for critical area planting can be found in Wisconsin Agronomy Technical Notes 5 and 6. Species not listed in the technical notes must be approved in advance by the State Agronomist.

a. Introduced Grass and Legume Plantings on Critical Sites

Custom and standard mixtures will comprise of at least 50 percent grass seed, consisting of at least 25 percent sod forming grass seed per square foot.

A minimum of 160 seeds per square foot is required for either a solid stand of grasses or a combination of grasses and legumes. Increase seeding rate by 15 percent when dormant seeding occurs.

Standard mixes listed in Table 5 will meet the minimum seed mixture criteria.

b. Native Herbaceous Plantings on Critical Sites

Native species are generally not recommended for critical area plantings due to their slow establishment and because they are clump grasses, not the preferred sod-forming grasses. Native plantings are not permitted in concentrated flow channels.

1) A minimum of 60 seeds per square foot for solid native grass plantings is required.

2) For native grass and forb/legume mixtures, a minimum of 40 seeds per square foot of grass and a minimum of 20 seeds per square foot for the forb/legume component is required. The minimum of 20 forb/legume seeds per square foot is not required when the solid stand native grass mixture comprise of 60 grass seeds per square foot is utilized.

Canada/Virginia wildrye and sideoats grama shall not exceed a maximum of 20 percent of the required grass seeds per square foot in custom seed mixtures.

C. **Additional Criteria to Stabilize Stream Channel Banks and Shorelines**

Wisconsin FOTG Standard 580, Streambank and Shoreline Protection, shall be used to stabilize the toe and/or bank hydrologic zones before vegetation establishment.

1. Bank and Channel Slopes

Identify, mark, and protect desirable existing vegetation during practice installation.

On sites with a disturbed soil profile, topsoil will be stockpiled and spread over areas to be planted as needed to meet planting and land shaping needs.

Channel side slopes shall be shaped to a stable slope to facilitate establishment and maintenance of desired vegetation.

Slopes steeper than 2H:1V shall not be stabilized using vegetation alone. A combination of vegetative and structural measures will be used on these slopes to ensure adequate stability.

Grazing shall be permanently excluded on high hazard sites, such as cut banks, areas of seepage or other potentially unstable areas.

2. Species Selection

Plant material used for this purpose shall:

- be adapted to the hydrologic zone into which they will be planted.
- be adapted and proven in the regions in which they will be used.
- when mature, produce plant communities that are compatible with those already existing in the area.
- protect the channel banks but not restrict channel capacity.

D. Additional Criteria to Stabilize Areas of Erosion By Wind and Water

1. The amount of plant biomass and cover needed to reduce wind and water erosion to the planned soil loss objective shall be determined using the current approved wind and/or water erosion prediction technology.

2. Do not use tillage where desirable vegetation is already present or where soil disturbance will increase the potential for erosion or cause sedimentation to environmentally sensitive areas.

3. Use a companion crop as added protection.

E. Additional Criteria to Rehabilitate and Revegetate Degraded Sites That Cannot Be Stabilized Using Normal Establishment Techniques

Slope Stabilization

1. On sites that are too steep for regular seeding equipment to operate, the use of hydroseeding and mechanically blown mulch is recommended. For more information regarding hyrdoseeding, refer to Wisconsin Agronomy Technical Note 6.

2. Grade to a stable slope when shaping and eliminate all overfalls. For slopes steeper than 2H:1V, enhanced stabilization activities such as soil bioengineering may be required. These practice concepts shall follow approved design procedures located in the NRCS Engineering Field Handbook, Chapter 18.

3. The toe of the slope, or the outlet of the concentrated flow channel, shall be stable before attempting seeding on the slope.

4. Concentrated flow may need to be diverted from the critical area during the establishment period.

5. All gullies and deep rills will be filled and leveled during seedbed preparation.

6. A minimum of 4 inches of friable soil material or topsoil shall be added and mixed to exposed rocky, sandy, gravelly, shaley material, or extremely fine textured subsoil.

7. Sod placement shall be limited to areas that can naturally supply needed moisture or sites that can be irrigated during the establishment period.

8. Sod will be placed and anchored using techniques to ensure that it remains in place until established.

Figure 1
Planting Zones

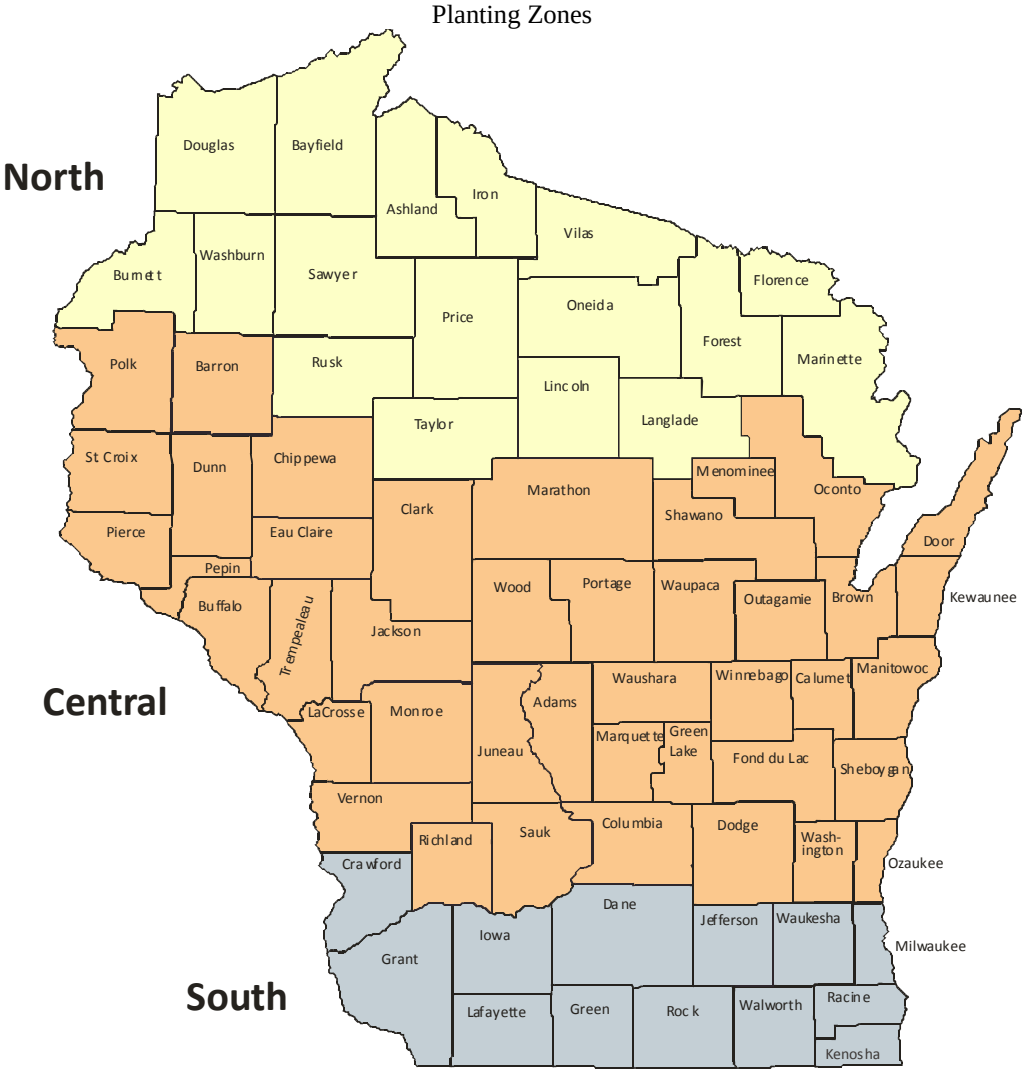


Table 1
Seeding Date/Ranges for Native Mixtures and Companion Crops

Zone	Spring Seeding
Northern	Thaw - 7/15
Central	Thaw - 6/30
Southern	Thaw - 6/30

Table 2
Seeding Date/Ranges for Introduced Grasses, Legumes, and Companion Crops

Planting Zone	Spring	Late Summer	Dormant
North	5/1 - 6/15	7/15 - 8/10	11/1 - Freeze up
Central	4/15 - 6/1	8/1 - 8/21	11/1 - Freeze up
South	4/1 - 5/15	8/7 - 8/29	11/1 - Freeze up

VI. Considerations

Additional recommendations relating to design that may enhance the use of, or avoid problems with, this practice but are not required to ensure its basic conservation functions are as follows.

A. Minimize activities which disturb wildlife during the primary nesting season May 15 through August 1.

B. Consider seeding at a lower rate and making 2 passes to ensure uniform coverage. Check seed boxes regularly to ensure even distribution.

C. Heavy traffic and/or compacted soil areas may need special site preparation prior to seeding.

D. Sprigs, root stocks, crowns, cones, culms, and sod may be considered where appropriate to accelerate the establishment of cover.

E. Woody shrubs or trees may be used only after initial stabilization. Plant in accordance with the purpose of the planting. See WI FOTG Standards 612, Tree/Shrub Planting; and 580, Streambank and Shoreland Protection. Also see NRCS Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection and Chapter 18, Soil Bioengineering for Upland Slope Protection.

F. Consider using carriers such as vermiculite, sawdust, and soybean meal to increase volume and weight for uniform seed distribution.

G. Consider limited or no use of herbicides one year prior to seeding. If herbicides must be used, ensure there is no potential for carryover and follow label recommendations. Follow WI FOTG Standard 595, Integrated Pest Management, for pesticide use and safety.

H. Consider sodding to establish vegetation on steep slopes. For further details on this special erosion control measure, refer to Wisconsin Agronomy Technical Note 6.

I. Consider establishing a buffer of trees and/or grasses next to intermittent or perennial streams.

J. Consider planting native vegetation and/or local *genotypes* when restoring riparian corridors to its pre-settlement conditions.

K. High seed counts per square foot much above the recommended minimums may lead to excessive competition and poor establishment of some species. Seeds per square foot should not exceed 25 percent of the minimum requirement, with the exception of mixtures designed for wet mesic and wet sites.

L. Consider the use of *soil bioengineering* techniques to arrest and prevent slope failures and erosion. For approved design procedures, refer to Chapter 18 of the NRCS Engineering Field Handbook (EFH).

M. Consider alternatives to reduce or eliminate the delivery of sediment and associated pollutants into the riparian zone by implementing upland treatment practices.

VII. Plans and Specifications

Prepare plans and specifications for each field or management unit according to the Criteria and Operation and Maintenance sections of this standard. Specifications shall describe the requirements for applying this practice to meet the intended purpose using the appropriate specification and/or job sheets. The following elements shall be addressed in the plan, as applicable, to meet the intended purpose.

- Site preparation.
- Fertilizer application.
- Methods of seeding/planting.
- Selection of species.
- Analysis of seed quality.
- Seeding rate (adjusted based on pure live seed calculations).
- Target number of plants per square foot after emergence.
- Mulching (if applicable).
- Temporary cover (if applicable).
- Companion crop (if applicable).
- Weed control activities during the establishment period.

Specifications shall be recorded using Wisconsin Job Sheets 134, How to Establish and Maintain Introduced Grasses and Legumes; and 135, How to Establish and Maintain Native Grasses, Forbs, and Legumes.

VIII. Operation and Maintenance

A. Noxious weeds and other undesirable species must be controlled at all sites. During the first year, mow plantings at 14 to 21-day intervals or when weeds are 12-14 inches high and before the development of mature seed. Mowing height

should be 4 inches for introduced and 7 inches for native plants. Small grain companion crops should be mowed at boot stage and prior to heading. Spot spraying or hand pulling may be needed for some invasive species such as thistles and purple loosestrife.

B. Sites may require on-going periodic maintenance consisting of mowing, burning, or herbicide treatment.

C. Sites should be inspected periodically to ensure site stabilization objectives are being met.

IX. References

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Packard, S. and Mutel, C. 1997. The Tallgrass Restoration Handbook for Prairies, Savannas and Woodlands. Society for Ecological Restoration.

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USDA, NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook.

USDA, NRCS, Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

USDA, NRCS, Wisconsin Agronomy Technical Note 5, Establishing and Maintaining Native Grasses, Forbs, and Legumes.

USDA, NRCS, Wisconsin Agronomy Technical Note 6, Establishing and Maintaining Introduced Grasses and Legumes.

USDA, NRCS, Wisconsin Job Sheet 134, How to Establish and Maintain Introduced Grasses and Legumes.

USDA, NRCS, Wisconsin Job Sheet 135, How to Establish and Maintain Native Grasses, Forbs, and Legumes.

X. Definitions

Actual Adjusted Seeding Rates (V.A.2.) – an increase in seeds per square foot or pounds per acre, when the PLS is less than 100 percent.

Aspect (V.A.1.) – The exposure of the site to direct sunlight, prevailing winds, and other factors that influence plant growing conditions. For example, a north slope tends to be cooler and moister while a south-facing slope tends to be drier and warmer.

Soil Bioengineering (VI.L.) – Practice of combining mechanical, biological, and ecological concepts to arrest and prevent shallow slope failures and erosion.

Certified Seed (V.A.2.) – Seed that meets the standards established by the designated official seed certifying agency for the purpose of ensuring species/variety, species/varietal purity and mechanical quality. The Wisconsin Crop Improvement Association is the official seed certifying agency for Wisconsin.

Genotype (VI.J.) – A group of individual plants which share a specified genetic makeup. For example, all big bluestem plants that are genetically adapted to grow and mature in the climatic conditions found in the driftless region could be considered a genotype.

Introduced Species (V.A.4.) – Plant species that historically were not native to North America and were brought here from other parts of the world, for example, smooth bromegrass and alfalfa.

Native Species (V.A.4.) – Plants species that historically would have been found growing in North America such as big bluestem or green needle-grass.

Non-Certified Seed (V.A.2.) – Seed that is grown, processed, tested and labeled for species/variety and mechanical quality factors, but is not certified by an official seed certifying agency.

Pure Live Seed (PLS) (V.A.2.) – PLS is a means of expressing seed quality, based on the percentage of seed in a seed lot that is both pure and viable. PLS is calculated by multiplying the percentage of total viable seed (germination + hard seed + dormant seed) by the percentage of pure seed divided by 100.

Untested Seed (V.A.2.) – Seed that has no assurances of testing for species/variety and mechanical quality, i.e., species/variety purity, inert matter, other crop or weed seeds and germination potential. Untested seed legally cannot be labeled.

Table 3
Common Species and Seeding Rates for Critical Area Plantings

Common Name	Scientific Name	Moisture Regime	Single Species Seeding Rate (PLS) Lbs./Ac.	Seeds/Lb.	Seeds/Square Ft./Lb./Ac.
Native Grasses					
Big Bluestem[1]	Andropogon gerardii[1]	D, DM, M, WM	11	165,000	3.8
Canada Wild Rye	Elymus canadensis	DM, M, WM	12	83,200	1.9
Indian Grass[1]	Sorghastrum nutans[1]	D, DM, M, WM, W	10	192,000	4.4
Little Bluestem	Schizachyrium scoparium	D, DM, M	8	240,000	5.5
Prairie June Grass	Koeleria macrantha[1, 2]	D, DM, M	0.5	2,308,672	53
Sideoats Grama	Bouteloua curtipendula	D, DM, M	8	127,000	2.9
Switch Grass[1]	Panicum virgatum[1]	D, DM, M, WM, W	7	389,000	8.9
Virginia Wild Rye	Elymus virginicus	M, WM, W	17	67,200	1.5
Introduced Grasses					
Chewings Red Fescue[2]	Festuca rubra L. ssp. fallax[2]	D, DM, M	5	350,000	8
Creeping Red Fescue[1, 2]	Festuca rubra[1, 2]	DM, M, WM	5	350,000	8
Festulolium	Festuca x Lolium	DM, M, WM	10	227,000	5.2
Italian or Annual Ryegrass	Lolium perenne L. ssp. multiflorum	DM, M, WM	20	227,000	5.2
Kentucky Bluegrass[1, 2]	Poa pratensis[1, 2]	D, DM, M, WM, W	8	2,177,000	50
Orchard Grass	Dactylis glomerata L.	D, DM, M, WM	10	653,000	15
Perennial Ryegrass	Lolium perenne	DM, M, WM	20	227,000	5.2
Redtop[1, 2]	Agrostis gigantea[2]	M, WM, W	4	4,990,000	114.5
Smooth Bromegrass[1, 2]	Bromus inermis[1, 2]	D, DM, M, WM	20	136,000	3.1
Tall Fescue	Schedonorus arundinaceus	D, DM, M, WM	12	227,000	5.2
Timothy	Phleum pratense	DM, M, WM, W	8	1,230,000	28.2
Legumes					
Alfalfa	Medicago sativa	D, DM, M	12	219,000	5.0
Alsike Clover	Trifolium hybridum	M, WM, W	3	680,000	15.6
Birdsfoot trefoil	Lotus corniculatus	DM, M, WM, W	7	375,000	8.6
Red Clover	Trifolium pratense	DM, M, WM	10	275,000	6.3
White Ladino Clover	Trifolium repens	DM, M, WM	3	871,650	20

[1] Species approved for seeding individually at the recommended Pure Stand Rates based on Pure Live Seeds (PLS) depending on the erosiveness of the site.

It is required that at least 50% of the seeds per square foot of mixtures planted to introduced and native species on critical areas are composed of grasses, and 25% of the seeds per square foot are sod-forming grasses for introduced species.

If more than 20% of the legume seed is hard seed, increase the seeding rate for legumes by the percent of hard seed.

Seeds per square foot for a particular specie can be calculated by multiplying the number of seeds per pound of the specie by the rate of the specie in pound(s) per acre divided by 43,560 square feet.

[2] Sod-forming grass plants.

Table 4
Seeding Chart for Native Grass Species

Common Name	Scientific Name	Percent of Mixture	Pure Stand Seeding Rate	Seeds per Square Foot
Big Bluestem	Andropogon gerardii	0-100	11 lbs/ac	42
Canada Wildrye	Elymus canadensis	0-20	12 lbs/ac	23
Indian grass	Sorghastrum nutans	0-100	10 lbs/ac	44
Little Bluestem	Schizachyrium scoparium	0-20	8 lbs./ac	44
Sideoats Grama	Bouteloua curtipendula	0-20	8 lbs/ac	23
Switchgrass	Panicum virgatum	0-100	7 lbs/ac	63
Virginia Wild Rye	Elymus virginicus	0-20	17 lbs/ac	26
Praire June Grass	Koeleria macrantha	0-20	0.5 lbs/ac	26
Hairy Grama	Bouteloua hirsuta	0-25	1 lb/ac	26

Canada Wild Rye, Virginia Wild Rye and Sideoats Grama when combined will not comprise of more than 20% of the total grass seeds per square foot. Pure stand seeding rates for Big Bluestem and Indiangrass must be increased by 5 lbs/acre to meet the minimum seeds per square foot as required by this standard. Refer to Table 3 for suggested moisture regimes per specie.

Table 5
Seeding Mixtures Suitable for Critical Area Plantings

Seed Calculator Code*	Moisture Regimes	Common Name	Scientific Name	Seeding Rate in lb/ac PLS	Seeding Rate in Seeds/Ft^2 PLS	Capacity Retardance	Type of Site**
342-1	*Dry-Mesic* and *Mesic* Sites	Smooth Bromegrass	Bromus inermis	10	31	B	EB, WW,CSB
		Creeping Red Fescue	Festuca rubra	3	24		
		Alfalfa	Medicago sativa	3	15		
		Red Clover	Trifolium pratense	3	19		
		Kentucky bluegrass	Poa pratensis	1.5	75		
342-2	Dry-Mesic and Mesic Sites***	Smooth Bromegrass	Bromus inermis	15	47	B	EB,WW
		Alfalfa	Medicago sativa	7	35		
		Timothy	Phleum pratense	3	85		
342-3	Dry-Mesic and Mesic Sites	Kentucky bluegrass	Poa pratensis	1	50	B	CSB, EB, WW
		Smooth Bromegrass	Bromus inermis	10	31		
		Timothy	Phleum pratense	2	56		
		Tall Fescue	Schedonorus arundinacea	2	10		
		Perennial Ryegrass	Lolium perenne	5	26		
342-4	Dry-Mesic and Mesic Sites	Smooth Bromegrass	Bromus inermis	20	62	B	EB, WW, CSB
		Creeping Red Fescue	Festuca rubra	5	40		
		Alfalfa	Medicago sativa	8	40		
		Red Clover	Trifolium pratense	4	25		
342-5	Dry-Mesic and Mesic Sites	Smooth Bromegrass	Bromus inermis	30	93	B	EB, WW, CSB
		Alfalfa	Medicago sativa	14	70		
342-6	Dry-Mesic, Mesic, and Wet Mesic Sites	Smooth Bromegrass	Bromus inermis	7	22	B	CSB, EB, WW
		Timothy	Phleum pratense	2	56		
		Creeping Red Fescue	Festuca rubra	1	8		
		Kentucky Bluegrass	Poa pratensis	1	50		
		Perennial Ryegrass	Lolium perenne	3	16		
		Red Clover	Trifolium pratense	3	19		
342-7	Mesic Sites***	Smooth Bromegrass	Bromus inermis	7	22	B	EB, WW
		Creeping Red Fescue	Festuca rubra	2	16		
		Kentucky bluegrass	Poa pratensis	3	150		
		Birdsfoot trefoil	Lotus corniculatus	2	17		
342-8	Mesic Sites***	Smooth Bromegrass	Bromus inermis	15	47	B	WW,EB
		Creeping Red Fescue	Festuca rubra	2	16		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-9	Mesic Sites***	Kentucky Bluegrass	Poa pratensis	3	150	C	WW,EB
		Creeping Red Fescue	Festuca rubra	4	32		
		Perennial Ryegrass	Lolium perenne	10	52		
342-10	Mesic Sites	Smooth Bromegrass	Bromus inermis	14	43	B	EB, WW, CSB
		Timothy	Phleum pratense	3	85		
		Red Clover	Trifolium pratense	3	19		
		Perennial Ryegrass	Lolium perenne	4	21		
342-11	Mesic Sites	Smooth Bromegrass	Bromus inermis	32	99	B	EB, WW
		Creeping Red Fescue	Festuca rubra	8	64		
342-12	Mesic Sites	Kentucky bluegrass	Poa pratensis	4	200	C	EB, WW
		Creeping Red Fescue	Festuca rubra	3	24		

Seed Calculator Code*	Moisture Regimes	Common Name	Scientific Name	Seeding Rate in lb/ac PLS	Seeding Rate in Seeds/Ft^2 PLS	Capacity Retardance	Type of Site**
342-13	Mesic Sites	Smooth Bromegrass	Bromus inermis	14	43	B	EB, WW, CSB
		Timothy	Phleum pratense	4	113		
		Red Clover	Trifolium pratense	3	19		
342-14	Mesic Sites	Smooth Bromegrass	Bromus inermis	15	47	B	EB, WW, CSB
		Timothy	Phleum pratense	3.5	99		
		Alsike Clover	Trifolium hybridum	2	32		
342-15	Mesic Sites	Smooth Bromegrass	Bromus inermis	15	47	B	EB, WW
		Timothy	Phleum pratense	3.5	99		
		Birdsfoot trefoil	Lotus corniculatus	3	26		
342-16	Wet Mesic Sites	Tall Fescue	Schedonorus arundinacea	5	26	B	CSB, EB, WW
		Timothy	Phleum pratense	3	85		
		Perennial Ryegrass	Lolium perenne	3	16		
		Red Clover	Trifolium pratense	3	19		
		Smooth Bromegrass	Bromus inermis	6	19		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-17	Wet Mesic Sites	Redtop	Agrostis gigantea	1	115	C	WW, CSB, EB
		Timothy	Phleum pratense	3	85		
		Red Clover	Trifolium pratense	5	32		
342-18	Wet Mesic Sites	Timothy	Phleum pratense	3	85	B	WW, CSB, EB
		Perennial Ryegrass	Lolium perenne	3	16		
		Red Clover	Trifolium pratense	3	19		
		Smooth Bromegrass	Bromus inermis	6	19		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-19	*Wet Mesic* Sites	Redtop	Agrostis gigantea	1	115	C	WW,CSB, EB
		Timothy	Phleum pratense	1	28		
		Red Clover	Trifolium pratense	4	25		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-20	*Wet* Sites***	Redtop	Agrostis gigantea	2	229	C	WW
		Alsike Clover	Trifolium hybridum	2	31		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-21	Wet Mesic Sites	Redtop	Agrostis gigantea	3	344	C	WW
		Alsike Clover	Trifolium hybridum	3	47		

*These codes represent the mixtures used in the Wisconsin Seed Calculator.
**EB = Embankments; WW = Waterways; CSB = Channel and Streambanks
***Mixtures can be used on other site descriptions when not listed.

WASTE FACILITY CLOSURE

(No.)
Code 360

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

The decommissioning of facilities, and/or the rehabilitation of contaminated soil, in an environmentally safe manner, where agricultural waste has been handled, treated, and/or stored and is no longer used for the intended purpose.

II. Purpose

- Protect the quality of surface water and groundwater resources.
- Mitigate air emissions.
- Eliminate a safety hazard for humans and livestock.
- Safeguard the public health.

III. Conditions Where Practice Applies

This practice applies to agricultural waste storage facilities that are no longer needed as a part of a waste management system and are to be permanently closed or converted for another use.

This practice applies where impoundments that are to be converted to fresh water storage meet current NRCS standards.

This practice applies to removal of soil contaminated by agricultural wastes that have been stored at the *animal production area*[1].

This practice does not apply to sites contaminated by materials that are considered hazardous wastes or are subject to specific clean-up criteria in state or federal laws, such as fuel or pesticides.

IV. Federal, Tribal, State, and Local Laws

The closure of waste facilities shall comply with all federal, tribal, state, and local laws, rules or regulations. The operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state, or local laws governing closure of waste facilities, including national pollutant discharge elimination system (NPDES) requirements.

V. Criteria

A. General Criteria

Existing waste transfer components that convey waste to facilities or provide drainage from the facility area shall be removed and replaced with compacted earth material or otherwise rendered unable to convey waste.

Remove manure and agricultural waste from the storage facility and waste transfer system. All manure and agricultural waste that could negatively impact water and/or air quality or pose a safety hazard shall be removed. All liquid, slurry, sludge, and solid waste, and soil removed from the facility shall be utilized in accordance with Wisconsin NRCS Field Office Technical Guide, Section IV (WI FOTG), Conservation Practice Standard 590, Nutrient Management. In lieu of field application, removed soil may also be thinly spread as topsoil at the closure location and vegetated.

Fill may include solid waste materials exempt for use pursuant to Wisconsin Administrative Code, Section NR 500.08, including used brick, building stone, concrete, reinforced concrete, broken pavement, and unpainted and untreated wood. If these materials are used, they shall be covered with at least 3 feet of clean mineral soil, with the most impermeable cover soil placed in the top one foot. If the area will have a soil surface, it shall also be covered with at least 3 inches of topsoil and be vegetated.

A minimum allowance of 5 percent of the fill height shall be provided for settlement. Finished grades shall provide a minimum 2 percent positive drainage from the closed facility and/or materials buried on site.

[1]Words in the standard that are shown in italics are described in IX. Definitions. The words are italicized the first time they are used in the text.

Precautions (fencing and warning signs) shall be used where necessary to ensure that the facility is not used for purposes incompatible with the facility modification.

Entry into an enclosed waste storage or waste transfer component shall not be allowed unless procedures published in ASABE Standard 470, Manure Storage Safety, are followed.

Erosion and Pollution Control. All disturbed areas shall be re-vegetated or treated with other suitable measures used to control erosion and restore the aesthetic value of the site. Sites, not suitable for re-vegetation through normal cropping practices, shall be vegetated in accordance with WI FOTG Standard 342, Critical Area Planting.

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.

Liquid and Slurry Waste Removal. Liquid and slurry wastes shall be agitated and pumped out to the maximum extent possible. Water shall be added as necessary to facilitate the agitation and pumping.

Sludge (Accumulated Solids) Removal. During sludge removal operations, the integrity of the liner, if one is present, shall be maintained to the extent possible to minimize the volume of contaminated soil removal.

Liner Removal.

1. Flexible membrane liners shall be:

   - Removed and properly disposed of, or
   - Cleaned and rendered unable to impound water (punctured).

   Removed flexible membrane liners may be buried within the closure with a minimum cover of 3 feet of mineral soil.

2. Concrete liners shall be:

   - Removed and properly disposed of, or
   - Cleaned and rendered unable to impound water (punctured), or
   - Cleaned and remain in place if the site grade allows rainfall to drain off the concrete surface.

   Removed concrete liners may be buried within the closure with a minimum cover of 3 feet of mineral soil.

   Foundry sand previously placed under NR 538, Beneficial Use of Industrial Byproducts, will require site-specific Wisconsin Department of Natural Resources (WDNR) approval of the closure plan.

3. Constructed clay liners shall be:

   - Completely removed, or
   - Rendered unable to impound water (partially excavated), or
   - Remain in place if the site grade allows rainfall to drain off the surface.

Contaminated Soil Removal. Earthen waste storage facilities shall have a minimum of 6 inches of soil removed from the bottom and sides of the entire facility.

Flexible membrane, concrete, or soil liners shall be systematically investigated for leaks and contaminated soils (soil mixed with waste) beneath them. When contaminated soils are found, the liner must be removed to the extent necessary and contaminated soil removed.

The extent (area and depth) of contaminated soil to be removed shall be determined by color, odor, or consistency of the soil indicating permeation or saturation with waste. A minimum depth of 6 inches of soil shall be removed.

B. Additional Criteria Applicable to Impoundment Closure or Conversion

1. *Embankment Impoundments* shall be breached so that they no longer impound waste. Portions of the embankment may remain in place. The slopes and bottom of the breach shall be stable for the soil material involved, however the side slopes shall be no steeper than three horizontal to one vertical (3:1).

   The embankment material can be graded into the impoundment area; compacted in accordance with Wisconsin Construction Specification 3, Earthfill; and the area vegetated for another use.

2. Excavated Impoundments shall be backfilled and compacted in accordance with

Wisconsin Construction Specification 3, Earthfill, so that these areas may be reclaimed for other uses.

3. Impoundments converted to fresh water storage.

   The impoundment shall be closed in accordance with V.A. and converted to a use that meets the requirements as set forth in the appropriate NRCS practice standard for the intended purpose. Where the original impoundment was not constructed to meet NRCS standards, the investigation for structural integrity shall be in accordance with National Engineering Manual (NEM) 501.23. When it is not possible to remove all the sludge and contaminated soils from a waste impoundment that is being converted to fresh water storage, the impoundment shall not be used for fish production, swimming, or livestock watering until the water quality is adequate for these purposes.

C. Additional Criteria Applicable to Fabricated Liquid Waste Facilities

If fabricated structures are to be demolished, disassembled or otherwise altered, it shall be done to such an extent that no water can be impounded. Disassembled materials such as pieces of metal shall be temporarily stored in such a manner that they do not pose a hazard to animals or humans until their final disposition.

Demolished materials shall be buried on-site within the facility or moved off-site to locations designated for such use by state or local officials. If buried on-site, the materials are to be covered with soil to a settled depth of at least 3 feet.

Under-building reception structures, channels, or storage structures may be filled with clean mineral soil, sand, or controlled low strength materials (flowable fill) after complete removal of manure. The fill shall be surfaced with concrete, gravel, or other material appropriate for the intended use following closure.

VI. Considerations

Considerations include additional design recommendations that are not required criteria, but may be used to enhance or avoid problems with the design and function of this practice.

A. Conduct pre-closure soil and water (surface and subsurface) testing to establish base line data surrounding the site at the time of closure. Establishing baseline data can be used in the future to address soil and water issues.

B. Alternative methods of sludge removal may be required where the impoundments contain large amounts of bedding, oyster shells, soil, or other debris.

C. Minimize the impact of odors associated with land applying dry wastes and with agitation, emptying, and land applying wastewater and sludge from a waste impoundment by conducting these operations at a time when the humidity is low, when winds are calm, and when wind direction is away from populated areas. Adding chemical and biological additives to the waste prior to agitation and emptying can reduce odors. Odor impacts from land application can also be mitigated by using an incorporation application method.

D. Minimize agitation of the wastes to only the amount needed for pumping to reduce the potential for release of air emissions.

E. Soil to fill excavated areas should not come from important farmlands (prime, statewide, local, and/or unique).

F. If large-size material or wood is used as fill, consideration shall be given to filling methods and additional thickness of clean mineral soil cover to prevent and accommodate excess settling. It may be necessary to limit the quantity of wood, because it degrades.

G. Waste facility closure may improve utilization and aesthetics of the farmstead.

H. Breached embankments may detract from the overall aesthetics of the operation. Embankments should be removed and the site returned to its original grade.

I. Disassembled fabricated structures may be suitable for assembly at another site. Care should be taken during closure to minimize damage to the pieces of the facility, particularly coatings that prevent corrosion of metal pieces.

J. Measures should be taken during contractor's activities 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.

K. To minimize potential impacts to livestock, such as nitrate poisoning, initiate a testing and monitoring program of nutrient levels in crop products, particularly livestock feeds, harvested from sites of closed animal confinement facilities.

VII. Plans and Specifications

Plans and specifications for the decommissioning of abandoned waste facilities and the rehabilitation of contaminated soil shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. At a minimum, include the following:

- A plan view showing the location and extent of the practice.
- Pertinent elevations and cross sections of the existing facility and excavation limits.
- Number, capacity, and quality of facility(ies) and estimate of liner material and soil volume to be moved.
- Location of known utilities.
- Requirements for salvage and disposal of structural or liner materials.
- Vegetative requirements.
- Utilization Plan for animal wastes and soil.
- Odor management or mitigation requirement.
- Safety plan requirements. Note: Per Occupational Safety and Health Administration (OSHA) confined space entry protocol, personnel shall not enter confined space of an enclosed waste facility without breathing apparatus or taking other appropriate measures.

VIII. Operation and Maintenance

The proper decommissioning and rehabilitation of a waste facility should require little or no operation and maintenance. However, if it is converted to another use, such as a fresh water facility, operation and maintenance shall be in accordance with the needs as set forth in the appropriate NRCS conservation practice standard for the intended purpose.

IX. Definitions

Animal Production Area (III.) – Means any part of the livestock operation that is used for the feeding and housing of livestock. This includes the entire animal confinement and feeding area, and any adjacent manure storage areas, raw materials storage areas, and waste containment areas. This does not include pasture and cropland.

Embankment Impoundments (V.B.1) – those with a depth of waste at the design level that is three feet or more above natural ground.

X. References

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

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

Wisconsin Administrative Code, Department of Natural Resources, Chapter NR 500, General Solid Waste Management Requirements.

Wisconsin Administrative Code, Department of Natural Resources, Chapter NR 538, Beneficial Use of Industrial Byproducts.

American Society of Agricultural and Biological Engineers (ASABE) Standard 470, Manure Storage Safety.

Rice, J.M., D.F. Caldwell, and F.J. Humenik. Ed. 2006. Closure of Earthen Manure Structures in Animal Agriculture and the Environment: National Center for Manure and Animal Waste Management White Papers. ASABE. Pub. Number 913C0306.

FENCE

(Feet)
Code 382

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A constructed barrier to animals or people.

II. Purposes

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- exclude livestock or wildlife from areas needing protection;
- confine livestock within an area;
- regulate domestic livestock access to areas while permitting wildlife movement;
- subdivide grazing land to permit use of managed grazing systems; or
- regulate access to areas by people, including vehicles, and/or to prevent trespassing for safety purposes.

III. Conditions Where Practice Applies

This practice may be applied on any area where control of livestock and/or wildlife movement is needed, or where human access is to be regulated. Fences are not needed where natural barriers will serve the purpose.

IV. Federal, Tribal, State and Local Laws

Users of this standard shall be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing fences. This standard does not contain the text of the federal, tribal, state or local laws.

V. Criteria

A. General Criteria

1. Fencing shall consist of the acceptable type as defined by Table 1, Fence Selection Criteria, as necessary to adequately control the movement of animal(s) or people to meet the intended management objective.

2. Fencing shall consist of acceptable designs, materials, and methods as described in the Wisconsin Engineering Spreadsheet, Fence Design and Drawings; and Wisconsin NRCS FOTG, Section IV, Construction Specification 10, Fence.

3. Fences may be permanent, portable, or temporary and shall be positioned to facilitate the management requirements.

4. Property boundary line fences shall comply with state laws and standards for construction (Ch. 90, Wis. Stats.).

5. Fencing materials shall be of a high quality and durability, and the construction performed to meet the practice design.

6. Height, number, and spacing of wires will be installed to facilitate control and management of the animals and/or people, as shown in Table 1. Height, size, spacing, and type of posts used shall meet the needs of the planned fence type and the topography of the site.

7. Barbed wire shall not be electrified or insulated for electrification.

8. Manufacturer's guidelines shall be adhered to during installation and shall meet the minimum construction specifications for each type of fence to ensure proper component assembly.

9. If electric fences must pass under overhead high voltage power lines, cross the power lines as close to perpendicular as possible.

   The maximum height of the top wire of the fence shall be 6 feet.

10. Gates shall be placed at corners or other convenient locations as necessary to facilitate access to the site. Position gates on flat, firm ground to avoid erosion and standing water.

11. When the intended use of the fence system is to restrict access to safety hazards by people and animals, the fence and gates shall be a minimum of 48 inches above grade and shall not allow passage of a larger than a 6-inch sphere between any fence or gate member. The maximum distance between the bottom of the fence or gate and the ground shall be 6 inches. All fence openings shall have gates that can be shut and securely fastened. All materials shall have sufficient durability and strength for the intended use. Additional safety features may be required depending on the hazard classification and site conditions.

12. When the intended use of the fence system is to restrict access by vehicles, the spacing between fence openings and the height above the ground shall be appropriate for the vehicle type to be restricted. Horizontal cross members across fence openings may be used to increase fence openings. All materials shall have sufficient durability and strength for the intended use. Access point(s) for authorized vehicles may have gates that can be shut and securely fastened.

    Gates or barriers associated with roads shall be adequately marked to safeguard human safety and minimize the risk of liability.

VI. Considerations

A. Consider installing fences in locations that will allow efficient movement of equipment and livestock and facilitate maintenance. Avoid irregular terrain such as gullies and/or water crossings if possible or include additional bracing or specially designed fence components.

B. Fences should be installed at least 8 feet from wooded areas to minimize damage by windfalls.

C. Consider creating a cleared right of way to facilitate fence construction and maintenance. Avoid critical activity periods of wildlife or threatened or endangered species when clearing the right of way and constructing the fence.

D. Consider wildlife movement needs when selecting fence materials and location.

E. Consider livestock management, handling, watering, and feeding practices typical to the site when locating fences.

F. Consider soil erosion potential when planning and constructing a fence on steep slopes.

G. Battery powered fences require more management to assure timely replacement of batteries. Extra batteries should be kept on hand to rotate during charging.

H. Consider the use of solar powered energizers for electric fences in remote locations.

I. Training areas should be used to condition new or young livestock to electric fences. Select a well-fenced area with an interior cross fence where the animals will come in contact with the fence. Normally a 24 hour exposure to the electric fence is adequate. When animals are approaching the fence with caution or staying a distance away, they are trained.

J. Consider raising the minimum height of the lower wire of fences located in the floodplain.

K. For electrified fences, consider safety recommendations and cautions from the energizer manufacturer and supplier.

L. Consider energizing an electrified fence 48 hours before turning in livestock to avoid damage by wildlife.

M. If an existing fence must be removed during construction, recycle or properly dispose of the old fence materials.

VII. Plans and Specifications

Plans and specifications are to be prepared for each specific field site, based on this standard. The plans will include operation and maintenance requirements (see Section VIII below). The Diggers Hotline (800-242-8511) shall be called by the landowner to locate underground utilities prior to fence construction. Fences shall be designed and constructed according to Wisconsin NRCS, FOTG, Section IV, Construction Specification 10, Fences.

The plan shall include the following.

- A map or sketch of the planned fence location.
- The type(s) of fence to be constructed shall be specified by location.
- The type and quality of fencing materials.
- Estimated quantities of fence materials needed.
- Appropriate detailed design drawings for corner assemblies, gates, and specialized components like stream crossings.
- Location of existing fences to be used or removed.
- For high tensile strength wire fences the planned location of fence tensioners and recommended wire tension to apply.
- For electric fences the recommended energizer installation location, installation details beyond manufacturer recommendations and minimum recommended power rating.
- Details of fencing right-of-way site preparation needs, activity avoidance periods to protect sensitive animal species and construction site erosion control.
- Disposal of old and/or scrap fencing materials.

VIII. Operation and Maintenance

A. Routine inspection of fences should be part of an ongoing management program. Inspection after storm events is needed to ensure the function of the intended use of the fence. Remove fallen limbs and maintain proper tension on the fence wires. Overhanging trees and limbs should be trimmed or removed as needed.

B. Perform maintenance and repairs as needed to facilitate the intended operation of the installed fence for the lifespan established by the practice design.

C. Regularly check electric fences to determine the voltage on the fence. If voltage is not sufficient, determine the cause and correct. During dry weather, ground rods may need water applied to soil around them. Clear brush from the fence line to reduce voltage loss. Vegetation should be controlled to maintain proper voltage and prevent stray voltage.

D. Floodgates must be maintained and kept clear of debris. During extended flooding periods, switch off the power to electrified floodgates.

E. Periodically inspect and repair/replace markers or other safety and control features as required.

F. Safety during construction and maintenance is a primary concern. Eye and hand protection should be worn during fence maintenance.

IX. References

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards; Fence (382), and Specifications; Wisconsin Construction Specification 10 Fence

Wisconsin Statutes, Chapter 90, Fences: http://www.legis.state.wi.us/statutes/Stat0090.pdf.

High-Tensile Wire Fencing, Northeast Regional Agricultural Engineering Service, Ithaca, NY.

Fences, USDI-Bureau of Land Management, USDA, Forest Service. Publication No. 2400, Range 8824 2803. July 1988.

Cadwallader, T. Understanding Electric Fence in "Grazing References Materials Manual," University of Wisconsin, Center for Integrated Agriculture Systems. January 1997.

Missouri Electric Fencing for Serious Graziers, USDA-Natural Resources Conservation Service, Missouri.

USDA, NRCS Wisconsin Engineering Spreadsheet, Fence Design and Drawings http://www.wi.nrcs.usda.gov/technical/eng_spreads.html.

Table 1
Fence Selection Criteria

Fence design and construction must meet the minimum requirements for controlling specific animal types.

Animal Type to Control	Fence Type	Purpose of Fence		Spacing Inches Above Ground Level (WW fences start 2-7 inches above the ground)
		Perimeter Around Mgt. Unit	Interior Subdivision	
Cattle	Barbed 3-wire	NO	Meets	18 to 42
Cattle	Barbed 4-wire	Meets	Exceeds	18 to 42
Cattle	Barbed 5-wire	Exceeds	Exceeds	18 to 42
Cattle	Non-Electric 4-wire high tensile smooth	NO	Exceeds	18 to 42
Cattle	Non-Electric 6-wire high tensile smooth	Meets	Exceeds	12 to 42
Cattle	Non-Electric 8-wire high tensile smooth	Exceeds	Exceeds	6 to 48
Cattle	Electric 1-wire high tensile smooth	NO	Meets	32
Cattle	Electric 2-wire high tensile smooth	NO	Exceeds	18, 36
Cattle	Electric 3-wire high tensile smooth	Meets	Exceeds	22 to 42
Cattle	Electric 4-wire high tensile smooth	Exceeds	Exceeds	12 to 42, minimum 2 hot
Cattle	Woven wire plus one or more top wire	Exceeds	Exceeds	47 minimum including wire
Cattle	Wood or Composition boards (6" wide), 4 boards	Exceeds	Exceeds	54 height, 6, 6, 8, 10 between boards
Cattle	HT Woven wire plus one or more top wires	Exceeds	Exceeds	47 minimum, 6 maximum between top wires
Goats & sheep	Non-Electric 5-wire high tensile smooth	NO	Meets	6 to 32
Goats & sheep	Non-Electric 6-wire high tensile smooth	NO	Exceeds	6 to 36
Goats & sheep	Non-Electric 7-wire high tensile smooth	Meets	Exceeds	6 to 42
Goats & sheep	Electric 3-wire high tensile smooth	NO	Meets	8, 18, 30
Goats & sheep	Electric 4-wire high tensile smooth	NO	Exceeds	8 to 36, minimum 2 hot
Goats & sheep	Electric 5-wire high tensile smooth	Meets	Exceeds	8 to 38, minimum 2 hot
Goats & sheep	Woven wire plus one or more top wire	Exceeds	Exceeds	47 minimum including wire
Goats & sheep	HT Woven wire plus one or more top wires	Exceeds	Exceeds	47 minimum including wire
Goats & sheep	HT woven electric	Exceeds	Exceeds	47 minimum including wire
Goats & sheep	Wood or Composition boards (6" wide), 4 boards	Exceeds	Exceeds	6, 6, 8, 10 between boards
Horses	Electric 2-wire high tensile smooth	NO	Meets	28, 38
Horses	Electric 3-wire high tensile smooth	Meets	Exceeds	28, 38, 48
Horses	Electric 4-wire high tensile smooth	Exceeds	Exceeds	18 to 48, minimum 2 hot
Horses	Electric 5-wire high tensile smooth	Exceeds	Exceeds	18 to 54, minimum 3 hot
Horses	Electric 1-wire Poly-Coated High Tensile Wire	NO	Meets	34
Horses	Electric 2-wire Poly-Coated High Tensile Wire	Meets	Meets	28, 38
Horses	Woven wire w/1 wire HT on top	Exceeds	Exceeds	54 including wire
Horses	Mesh "No climb" 2"x4" spacing	Exceeds	Exceeds	54 including wire
Horses	Wood or Composition boards (6" wide), 3 boards	Exceeds	Exceeds	12 minimum, 18 maximum between boards, 54 height
Hogs	Electric 2-wire high tensile smooth	NO	Meets	8, 16
Hogs	Electric 3-wire high tensile smooth	Meets	Exceeds	8, 16, 24
Hogs	Woven wire w/ 1 wire barb or HT	Exceeds	Exceeds	32 + barb or HT = 38
Hogs	Woven wire w/ 1 HT electric inside	Meets	Meets	32 + 1 electric wire 8 off ground inside of fence
Deer	Woven wire 96" tall	Meets	Meets	96 including wire
Bison	Electric 4-wire high tensile smooth	NO	Meets	16 to 42
Bison	Electric 5-wire high tensile smooth	NO	Exceeds	16 to 48
Bison	Electric 6-wire high tensile smooth	Meets	Exceeds	12 to 52
Chickens/turkey	Woven wire 2"x4" 1 wire HT or barb above	Exceeds	Exceeds	72 including wire
Emu and ostrich	Woven wire 6"x6" 1 wire HT or barb above	Exceeds	Exceeds	72 including wire
Chickens/turkey	HT Woven wire 2"x4" 1 wire HT or barb above	Exceeds	Exceeds	72 including wire
Emu and ostrich	HT Woven wire 6"x6" 1 wire HT or barb above	Exceeds	Exceeds	72 including wire

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

GRASSED WATERWAY

CODE 412

(ft.)

DEFINITION

A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet.

PURPOSE

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding.
- To prevent gully formation.
- To protect/improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

CRITERIA

General Criteria Applicable To All Purposes

Plan, design, and construct grassed waterways to comply with all federal, state, tribal, and local laws and regulations.

Drainage areas must be treated to minimize sediment deposition to the grassed waterway.

Capacity. Design the waterway to convey the peak runoff expected from the 10-year frequency, 24-hours duration storm. Increase capacity as needed to account for potential volume of sediment expected to accumulate in the waterway between planned maintenance activities. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. Ensure that the design capacity, at a minimum, will remove the water before crops are damaged.

Peak discharge for all storms will be determined by the method outlined in NRCS National Engineering Handbook (NEH), Part 650 - Engineering Field Handbook (EFH), Chapter 2; or Technical Release 55 (TR-55).

The vegetative retardance used shall consider the types of grasses to be seeded and the type of management anticipated. The retardance used shall be in accordance with the EFH, Chapter 7, Table 7-4.

Capacity of waterways shall be based on vegetative retardance A, B, or C.

Stability. Determine the minimum depth and width requirements for stability of the grassed waterway using the procedures in EFH, Chapter 7, Grassed Waterways; the Agricultural Research Service (ARS), Agriculture Handbook 667, Stability Design of Grass-Lined Open Channels, or the Handbook of Channel Design for Soil and Water Conservation (SCS-TP-61).

Ensure that the vegetation species selected are suited to the current site conditions and intended uses. Select species that have the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the waterway.

Stability of waterways shall be based on vegetative retardance C, D, or E.

Stability of waterways shall convey the peak discharge expected from the design storm without exceeding the allowable effective stress or permissible velocity.

Design velocities shall not exceed the values shown in Table 1.

Table 1

Waterway Slope Range (%)	Permissible Velocity[1]	
	Erosion Resistant Soils[2] (ft./sec)	Easily Erosded Soils[3] (ft./sec)
0-5	7	5
5.1-10	6	4
Over 10	5	3

[1]Use velocities exceeding 5 ft./sec only where good cover and proper maintenance can be obtained.

[2]Cohesive (clayey) fine-grain soils and coarse-grain soils with cohesive fines with a plasticity index of 10 to 40 (CL, CH, SC, and GC).

[3]Soils that do not meet the requirements for erosion-resistant soils.

Width. Keep the bottom width trapezoidal waterways less than 100 feet unless multiple, or divided waterway, or other means are provided to control meandering of low flows.

Side slopes. Keep the side slopes flatter than a ratio of two horizontal to one vertical (2:1). Reduce the side slopes as needed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting equipment so that damage to the waterway is minimized.

Depth. The capacity of the waterway must be large enough so that the water surface of the waterway is below the water surface of the tributary channel, terrace, or diversion that flows into the waterway at design flow.

The minimum designed depth of the waterway shall be 0.6 feet.

Provide 0.5 foot freeboard above the designed depth when flow must be contained to prevent damage. Provide freeboard above the designed depth when the vegetation has the maximum expected retardance.

Drainage. When needed to establish or maintain vegetation on sites having prolonged flows, high water tables, or seepage problems, use Wisconsin NRCS Field Office Technical Guide, Section IV (WI Standards), *Subsurface Drain (606), Underground Outlet (620)*, or other suitable measures in waterway designs.

Where drainage practices are not practicable or sufficient to solve these seepage problems, use Wisconsin NRCS Conservation Practice Standard (WI CPS), *Lined Waterway or Outlet (468)* in place of WI CPS, *Grassed Waterway (412)*.

All grassed waterways shall have stable inlet areas. The area downstream of bridges, culverts, or other structures shall be stabilized with durable lining materials if vegetation cannot be established.

Outlets. Provide a stable outlet with adequate capacity. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip or other suitable outlet.

Grassed waterways that serve as terrace outlets shall be established with adequate vegetation prior to the terrace construction.

Crossings. Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation. Crossings shall be in accordance with the criteria contained in WI CPS, *Stream Crossing (578), Access Road (560), or Trail and Walkways (575)*.

Vegetative Establishment. Establish vegetation as soon as possible using the criteria listed under "Establishment of Vegetation" in WI CPS, *Critical Area Planting (342)*.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock or straw or hay bale dikes, fabric or rock checks, filter fences, or runoff diversion to protect the vegetation until it is established. Planting of a close growing crop, e.g., small grains or millet, on the contributing watershed prior to construction of the grassed waterway can also significantly reduce the flow through the waterway during establishment.

CONSIDERATIONS

Where environmentally-sensitive areas need to be protected from dissolved contaminants, pathogens, or sediment in runoff, consider establishment of an increased width of vegetation on the waterway above the flow area. Increasing the width of the waterway above the flow area will increase filtering of sediment and pathogens as well as increase infiltration of runoff and increase nutrient removal. Where sediment control is the primary concern, consider using vegetation in the waterway which can withstand partial burial and adding sediment control measures above the waterway such as residue management. Consider increasing

the channel depth and/or designing areas of increased width or decreased slope to trap and store sediment to reduce the amount of sediment that leaves a field. Be sure to provide for regular cleaning out of the waterway when trapping sediment in this manner.

Tillage and crop planting often takes place parallel to the waterway, resulting in preferential flow – and resulting erosion – along the edges of the waterway. Consider installation of measures that ensure that runoff from adjacent areas will enter the waterway. Measures such as directing spoil placement or small swales can direct this preferential flow into the grassed waterway.

Avoid areas where unsuitable plant growth limiting subsoil and/or substratum material such as salts, acidity, root restrictions, etc. may be exposed during implementation of the practice. Where areas cannot be avoided, seek recommendations from a soil scientist for improving the condition or, if not feasible consider over-cutting the waterway and add topsoil over the cut area to facilitate vegetative establishment.

Avoid or protect, if possible, important wildlife habitat, such as woody cover or wetlands when determining the location of the grassed waterway. If trees and shrubs are incorporated, they should be retained or planted in the periphery of grassed waterways so they do not interfere with hydraulic functions. Medium or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands. When possible, select plant species that can serve multiple purposes, such as benefiting wildlife, while still meeting the basic criteria needed for providing a stable conveyance for runoff.

Water-tolerant vegetation may be an alternative to subsurface drains or stone center waterways on some wet sites.

Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Wildlife habitat benefits can be provided by adding width of appropriate vegetation to the sides of the waterway. Care should be taken to avoid creating small isolated planting zones that could become population sinks where wildlife attracted to an area experience reproductive loss due to predation.

Consider including diverse legumes, forbs, and flowering plants such as milkweeds that provide pollen and nectar for native bees and other pollinators. In dry regions, these sites may be able to support flowering forbs with higher water requirements and thus provide bloom later in the summer

The construction of a grassed waterway can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for grassed waterways that describe the requirements for applying the practice according to this standard. This should include:

- A plan view of the layout of the grassed waterway.
- Typical cross sections of the grassed waterway(s).
- Profile(s) of the grassed waterway(s).
- Disposal requirements for excess soil material.
- Site specific construction specifications that describe in writing the installation of the grassed waterway. Include specification for control of concentrated flow during construction and vegetative establishment.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

Provide an operation and maintenance plan to review with the landowner. Include the following items and others as appropriate in the plan.

- Establish a maintenance program to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.
- Protect the waterway from concentrated flow by using diversion of runoff or mechanical means of stabilization such as silt fences, mulching, hay bale barriers and etc. to stabilize grade during vegetation establishment.
- Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods. Permit grazing in the waterway only when a controlled grazing system is being implemented.

- Inspect grassed waterways regularly, especially following heavy rains. Fill, compact, and reseed damaged areas immediately. Remove sediment deposits to maintain capacity of grassed waterway.
- Avoid use of herbicides that would be harmful to the vegetation or pollinating insects in and adjacent to the waterway area.
- Avoid using waterways as turn-rows during tillage and cultivation operations.
- Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition. Mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.
- Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the waterway.
- Control noxious weeds.
- Do not use waterways as a field road. Avoid crossing with heavy equipment when wet.
- Lift tillage equipment off the waterway when crossing and turn off chemical application equipment.

REFERENCES

USDA, ARS. (1987). Stability design of grass-lined open channels. Washington, D.C.: U.S. Dept. of Agriculture, Agricultural Research Service.

USDA, NRCS (2007). National Engineering Handbook, Part 650, Engineering Field

Handbook, Chap. 7, Grassed waterways.

Stillwater Outdoor Hydraulic Laboratory (1954). Handbook of Channel Design for Soil and Water Conservation SCS-TP-61 (Revised. ed.). Washington: United States Department of Agriculture, Soil and Conservation Service.

PUMPING PLANT

(No.)

Code 533

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy source(s), and protective structures.

II. Purpose

This practice may be applied as part of a resource management system to achieve one or more of the following purposes:

- delivery of water for irrigation, watering facilities, wetlands, or fire protection;
- removal of excessive subsurface or surface water;
- providing efficient use of water on irrigated land;
- transfer of animal waste as part of a manure transfer system;
- improvement of air quality; and/or
- reduce energy use.

III. Conditions Where Practice Applies

This practice applies where conservation objectives require the addition of energy to pressurize and transfer water to maintain critical water levels in soils, wetlands, or reservoirs; transfer wastewater; or remove surface runoff or groundwater.

IV. Federal, Tribal, State, and Local Laws

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations, or permit requirements governing pumping plants. This standard does not contain the text of federal, tribal, state, or local laws.

V. Criteria

A. The following criteria apply to all purposes.

1. General

   The efficiency of units, type of power, quality of building, automation features, and other accessories installed shall be in keeping with the economic and environmental value of the system to accomplish the conservation objectives.

   Criteria for the design of components not addressed in NRCS practice standards shall be consistent with sound engineering principles.

2. Capacity

   The capacity of the pumping facility shall be adequate for the intended use. Livestock water requirements shall be in accordance with Wisconsin NRCS Field Office Technical Guide (FOTG), Section IV, Standard 614, Watering Facility.

3. Pump Requirements

   The capacities, range of operating lifts, and general class and efficiency of equipment shall be determined by appropriate technical means.

   The size and number of pumps and their performance shall be determined on the basis of the conservation system requirements in order to meet the intended purpose.

   The total head shall be determined for critical operating conditions, taking into account all hydraulic losses.

   Selection of pump materials shall be based on the physical and chemical qualities of the material being pumped and manufacturer's recommendations.

4. Power Units

   a. Power units shall be selected on the basis of availability of fuel or power costs, operating conditions, conservation needs, and objectives, including the need for automation and

other site-specific objectives. The power unit shall be matched to the pump and be capable of operating the pump efficiently and effectively within the range of operating conditions.

The power unit shall be sized to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Electric power units may include line power, photovoltaic panels, and wind or water powered turbines.

Electrical wiring shall meet the requirements of the National Electrical Code.

Renewable energy power units shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations.

b. Frequency Drives. The owner shall inform the electric power provider that a Variable Frequency Drive will be installed prior to installation, and be responsible for following requirements of the electric power provider.

The Variable Frequency Drive shall be protected against overheating.

The Variable Frequency Drive control panel shall provide the read out display of flow rate or pressure.

c. Photovoltaic panels. The photovoltaic array shall be sized based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. The photovoltaic array shall provide the power necessary to operate the pump at the design flow rate, with the appropriate service factor considering a minimum panel degradation of 10 years. Fixed arrays shall be oriented to receive maximum sunlight. Panel tilt angle shall be based on the location latitude and time of year for power requirements. Panels shall be mounted securely to resist movement by environmental factors.

d. Windmills. Pumping units shall be sized according to pumping lifts and capacities, as specified by the manufacturer. The diameter of the mill shall be based on the stroke length and the average wind speed. Towers shall be proportioned to the mill diameter, with adequate height for efficient and safe operation.

5. Hydraulic Rams

Hydraulic rams shall be of a size and capacity which shall meet the minimum pumping rates and volumes at the maximum anticipated total head and shall be installed in accordance with the manufacturer's recommendations. Adequate bypass facilities shall be provided to prevent erosion or unstable conditions resulting from the hydraulic ram operation.

Backflow prevention shall be incorporated when pumping from wells.

6. Suction and Discharge Pipes

To prevent cavitation, suction and discharge pipes shall be designed to account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude. The size of suction and discharge pipes shall be based on hydraulic analysis, operating costs, and compatibility with other system components.

Appurtenances such as gate valves, check valves, pressure reducing valves, pressure gages, pipe connections, and other protective devices, shall be included to meet the requirements of the application.

Screens, filters, trash racks, or other devices shall be installed as needed to prevent the intake of sand, gravel, debris, or other objectionable material into the pump. Intake screens shall be designed according to applicable Federal and State guidelines, to avoid entrainment or trapping of aquatic organisms.

Backflow prevention devices shall be included according to Federal, State, and Local laws, to prevent contamination of water sources connected to the pumping plant.

7. Building and Accessories

   Pumps shall be securely mounted on a solid foundation such as pilings or concrete. Foundations shall be designed to safely support the loads imposed by the pumping plant and appurtenances. Sheet piling or other measures shall be used, as required, to prevent piping beneath the foundation.

   Where buildings are necessary to protect the pumping plant, provisions shall be included for adequate ventilation and accessibility for equipment maintenance, repairs, or removal.

   Suction bays or sumps shall be designed to prevent the introduction of air at the intake.

   The discharge bay or the connection to the distribution system shall meet all hydraulic and structural requirements.

   Structures and equipment shall be designed to provide adequate safety features to protect operators, workers, and the public from potential injury. Drive shaft covers shall be required on all exposed rotating shafts.

B. Additional Criteria Applicable to Providing the Efficient Use of Water on Irrigated Land

Provisions for the connection of flow and pressure measurement devices shall be included in power plant system design.

C. Additional Criteria Applicable to the Improvement of Air Quality

Replacement pumping plants shall have lower total emissions of oxides of nitrogen and fine particulate matter, compared to the unit being replaced.

New, replacement, or retrofitted pumping equipment shall utilize a non-combustion power source, or cleaner-burning technologies or fuels.

D. Additional Criteria Applicable to Reduce Energy Use

For fossil fuel or electrical grid power sources, pumping plant installations shall meet or exceed the Nebraska Pumping Plant Performance Criteria, if applicable. Refer to NRCS National Engineering Handbook, Part 652, National Irrigation Guide, Table 12-2.

VI. Considerations

Additional recommendations relating to design which may enhance the use of, or avoid problems with, this practice, but are not required to ensure its basic conservation function are as follows.

A. Freezing weather conditions must be considered in the design of the pumping plant.

B. Consider the minimum water storage needed for livestock systems to satisfy the watering demands in a timely manner.

C. Consider effects on downstream flows, aquifer recharge volumes, or existing wetland hydrology.

D. Consider effects on surface or groundwater by leaked or spilled fuels and lubricants.

E. The operation and maintenance of a pumping plant can involve the use of fuels and lubricants that when spilled may adversely affect surface or ground water quality. Consider measures to protect the environment from potential spills. In some cases, secondary containment of spilled fuel may be required by Federal and State laws or regulations.

F. Pumping plants are often constructed in flood-prone areas or can be subject to other unexpected natural events. Consider how the pumping plant may be protected from extreme natural events and the consequences of damage or failure.

G. Include protective sensors to detect low or stopped flow, or pressures that are too high or too low.

H. The visual appearance of buildings or structures associated with the pumping plant should be compatible with the surrounding environment.

   When installing new or replacing existing combustion equipment, non-combustion and renewable energy sources, such as solar, wind, and water, should be considered.

VII. Plans and Specifications

Plans and specifications for constructing pumping plants shall be in accordance with this standard and describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications shall include the following:

- A plan view showing the location of the pumping plant in relationship to other structures or natural features.
- Detail drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components.
- Written specifications that describe the site specific details of installation.

VIII. Operation and Maintenance

An Operation and Maintenance plan specific to the facilities installed shall be prepared for use by the landowner or responsible operator. The plan shall provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly. The plan shall include provisions to address the following as a minimum.

- Inspection or testing of all pumping plant components, appurtenances, safety features, and secondary containment facilities as applicable.
- Proper start-up procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer's recommendations.
- When applicable, the power unit, fuel storage facilities, and fuel lines should be frequently checked for fuel or lubricant leaks and repaired as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures to assure adequate capacity reaches the pumping plant.
- Periodic removal of sediment in suction bays to maintain design capacity and efficiency.
- Inspect and maintain anti-siphon devices, if applicable.
- Routinely test and inspect all automation components of the pumping plant to assure they are functioning as designed.
- Inspect and maintain secondary containment facilities, if applicable.
- Procedures to protect the system from damage due to freezing temperatures.
- Periodic inspection of all safety features, to ensure proper placement and function.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.

IX. References

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

HEAVY USE AREA PROTECTION

CODE 561

(sq. ft.)

DEFINITION

Heavy use area protection is used to stabilize a ground surface that is frequently and intensively used by people, animals, or vehicles.

PURPOSE

Heavy use area protection is used:

- To provide a stable, non-eroding surface for areas frequently used by animals, people or vehicles.
- To protect or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where a frequently or intensively used area requires treatment to address one or more resource concerns.

CRITERIA

General Criteria Applicable To All Purposes

Design Load. Base the design load on the type and frequency of traffic, (vehicular, animal, or human) anticipated on the heavy use area.

Foundation. Evaluate the site foundation to ensure that the presumptive bearing capacity of the soil meets the intended design load and frequency use.

When necessary, prepare the foundation by removal and disposal of materials that are not adequate to support the design loads.

Use a base course of gravel, crushed stone, other suitable material, geotextile, or a combination of materials on all sites that need increased load bearing strength, drainage, separation of material and soil reinforcement. Refer to Natural Resources Conservation Service (NRCS), National Engineering Handbook (NEH), Part 642, Design Note 24, Guide for Use of Geotextiles; or NEH, Part 650, Engineering Field Handbook (EFH), Chapter 17, WI Supplement.

If there is the potential for groundwater contamination from the heavy use area, select another site or provide an impervious barrier. Option G in Table 1, Surface Material Criteria and Separation Distances, shall be used if protection from groundwater contamination is the primary objective.

Separation From Subsurface Saturation or Bedrock. The separation is the closest distance from any point on the top surface of the heavy use area protection to the feature from which separation is required. Separation distances are listed in Table 1.

Subsurface saturation and bedrock are defined in WI NRCS Conservation Practice Standard (WI CPS), *Waste Storage Facility (Code 313)*. The criteria for handling subsurface saturation and bedrock separation is also included in WI CPS 313.

Surface Treatment. Select a surface treatment that is stable and appropriate to the purpose of the heavy use area. Surfacing options are included in Table 1. Surface treatments must meet the following requirements according to the material used.

Concrete. Slabs-on-ground subject to cattle traffic or infrequent use by light agricultural equipment may utilize the surfacing options in Table 1.

Design slabs-on-ground subject to distributed stationary loads, light vehicular traffic, or infrequent use by heavy trucks or agricultural equipment in accordance with American Concrete Institute (ACI) *Guide for the Design and Construction of Concrete Parking Lots* (ACI 330R). Design slabs-on-ground subject to regular or frequent heavy truck or heavy agricultural equipment traffic in accordance with ACI *Guide to Design of Slabs-on-Ground* (ACI 360R). Design liquid-tight slabs in accordance with ACI Code *Requirements for Environmental Concrete Structures, Slabs-on-Soil* (ACI 350, Appendix H).

Design concrete structures in accordance with

NRCS National Engineering Manual (NEM), Part 536, Structural Engineering.

Bituminous Concrete Pavement. Refer to AASHTO Guide for Design of Pavement Structures or the applicable State highway department's specification for design criteria for bituminous concrete paving.

In lieu of a site-specific design for areas that will be subject to light use, pave with a minimum of 4 inches of compacted bituminous concrete over a subgrade of at least 4 inches of well-compacted gravel. Use bituminous concrete mixtures commonly used for road paving in the area.

Aggregate. Design aggregate surfaces for expected wear and intended use. In lieu of a site-specific design for areas that will be subject to cattle traffic or infrequent use by light agricultural equipment, utilize the surfacing options in Table 1.

For other applications, use NRCS Agricultural Engineering Note 4, *Earth and Aggregate Surfacing Design Guide*, or other appropriate methodology to design aggregate thickness.

Mulches. Use a minimum layer thickness of 6 inches for materials such as limestone screenings, cinders, tanbark, bark mulch, brick chips, or shredded rubber. Mulches are not recommended for livestock or vehicular applications.

Vegetation. Select vegetation that can withstand the intended use. Establish the vegetation in accordance with the criteria in WI CPS, *Critical Area Planting (Code 342)*.

Other. Other materials can be used if they will serve the intended purpose and design life.

Structures. When a roof is needed to address the resource concern, use WI CPS, *Roofs and Covers (Code 367)*. For non-waste applications, design structures according to the accepted engineering practice.

Drainage and Erosion Control. Include provisions in the design for surface and subsurface drainage, as needed. Include provisions for disposal and runoff without causing erosion or water quality impairment. To the extent possible, prevent surface water from entering the heavy use area.

Stabilize all areas disturbed by construction as soon as possible after construction. Refer to the criteria in WI CPS, *Critical Area Planting (Code 342)*, for establishment of vegetation. If vegetation is not appropriate for the site, use the criteria in WI CPS, *Mulching (Code 484)* to stabilize the disturbed area.

Additional Criteria for Livestock Heavy Use Areas

Other practices shall be utilized to collect, store, utilize, or treat manure and contaminated runoff where contaminated runoff will cause a resource concern.

Animal yards or lots shall be located a minimum of 50 feet from any well or sinkhole.

The animal yard area for various animal types and sizes; lot surfacing and feeding requirements shall be in accordance with the areas shown in the Wisconsin Supplement to Chapter 10 in the NRCS NEH Part 651, Agricultural Waste Management Field Handbook (AWMFH), or in livestock planning handbooks published by Midwest Plan Service.

Additional Criteria for Recreation Areas

The American Disabilities Act of 1990 (ADA) requires recreation areas that are used by the public to be accessible to people with disabilities. Address accessibility requirements for new construction and when existing facilities are being altered.

CONSIDERATIONS

Heavy use areas can have a significant impact on adjoining land uses. These impacts can be environmental, visual and cultural. Select a treatment that is compatible with adjoining areas. Consider such things as proximity to neighbors and the land use where the stabilization will take place.

Vegetated heavy use areas may need additional materials such as geogrids or other reinforcing techniques, or planned periods of rest and recovery to ensure that vegetative stabilization will succeed.

Consider the safety of the users during the design. Avoid slippery surfaces, sharp corners, or surfaces and structures that might entrap users. For heavy use areas used by livestock, avoid the use of sharp aggregates that might injure livestock.

Paving or otherwise reducing the permeability of the heavily used area can reduce infiltration and increase surface runoff. Depending on the size of the heavy use area, this can have an impact on the water budget of the surrounding area. Consider the effects to ground and surface water.

Installation of heavy use area protection on muddy sites can improve animal health. Mud transmits bacterial and fungal diseases and provides a breeding ground for flies. Hoof suctions makes it difficult for cattle to move around in muddy areas. In addition, mud negates the insulation value of hair coat and the animals must use more energy to keep warm. As temperatures fall, animal bunching may occur, which can reduce or eliminate vegetative cover and lead to erosion and water quality concerns.

To reduce the negative water quality impact of heavy use areas, consider locating them as far as possible from waterbodies or water courses. In some cases, this may require relocating the heavily used area rather than just armoring an area that is already in use.

To reduce the potential for air quality problems from particulate matter associated with a heavy use area, consider the use of WI CPS, *Windbreak/ Shelterbelt Establishment (Code 380), Herbaceous Wind Barriers (Code 603), Dust Control from Animal Activity on Open Lot Surfaces (Code 375), or Dust Control on Unpaved Roads and surfaces (Code 373)* to control dust from heavy use areas.

Consider ways to reduce the size of the heavy use areas as much as possible. This may require changes in how the livestock are managed, but in the long run, may result in less maintenance and a more efficient operation.

For areas that will need to be cleaned frequently by scraping, loose aggregate or other non-cementitious materials may not be the best choice. Consider a more durable surface such as concrete.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for heavy use area protection that describe the requirements for installing the practice according to this standard. As a minimum, the plans and specifications should include:

- A plan view showing the location and extent of the practice. Include the location and distances to adjacent features and known utilities.
- Typical section(s) showing the type and required thickness of paving or stabilization materials.
- A graded plan, as needed.
- Where appropriate, plans for required structural details.
- Method and materials used to stabilize areas disturbed by construction.
- Construction specifications with site specific installation requirements.

OPERATION AND MAINTENANCE

Prepare an Operation and Maintenance (O&M) plan and review with the operator prior to practice installation. The minimum requirements to be addressed in the O&M plan are:

1. Periodic inspections – annually and immediately following significant rainfall events.
2. Prompt repair or replacement of damaged components especially surfaces that are subjected to wear or erosion.
3. For livestock heavy use areas, include requirements for the regular removal and management of manure, as needed.
4. For vegetated heavy use areas, restrict use as needed to protect the stand and to allow vegetative recovery.

REFERENCES

American Concrete Institute (2006). Guide to Design of Slabs-on-Ground (ACI Standard 360R-06). Farmington Hills, MI: American Concrete Institute.

American Concrete Institute. Guide for the Design and Construction of Concrete Parking Lots. (ACI 330R-08). Farmington Hills, MI.: American Concrete Institute.

American Concrete Institute. Requirements for Environmental Concrete Structures, Slabs on Soil (ACI 350, Appendix H). Farmington Hills, MI: American Concrete Institute.

USDA, NRCS. National Engineering Handbook, Park 650, Engineering Field Handbook, Chapter 10.

USDA, NRCS (2014). Agricultural Engineering Note 4, Earth and Aggregate Surfacing Design Guide, Washington, DC.

Table 1: Surface Material Criteria and Separation Distances

Option	Fondation Condition	Cross Section Option	Separation to Bedrock or Subsurface Saturation (ft.)
A	Firm[1]	Raised Earth	3
B	Firm	Minimum 6” crushed stone[2]	3
C	Firm	Minimum 6” crushed stone over NRCS Wisconsin Construction Specification (WCS)-13, Geotextile, Class IV	3
D	Firm	Minimum 4” crushed stone over 6” base course of graded rock[3]	3
E	Firm	5” non-reinforced concrete with maximum control joint spacing of 16’ in both length and width, over 6” sand/gravel	2
F[4]	Firm	5” reinforced concrete with designed control joint spacing over 6” sand/gravel	2
G[5]	Firm	5” reinforced concrete with waterstop, over 6” sand/gravel	2
H	Firm	5” concrete reinforced with temperature and shrinkage steel only	2
I	Firm	Minimum 4” asphalt over 6” sand/gravel	3
J	Soft[1]	Minimum 4” crushed stone over 8” base course of graded rock over 6” of sand and fine gravel	3
K	Soft	Minimum 4” crushed stone over 8” base course of graded rock over NRCS WCS-13, Geotextile, Class IV	3
L	Soft	Minimum 4” crushed stone over 18” base course of graded rock	3
M	Soft	Minimum 4” crushed stone over 18” base course of graded rock over 6” sand and gravel	3
N	Soft	Minimum 8” crushed stone over geogrid over NRCS WCS-13, Geotextile, Class IV	3

[1]Guidance can be found in EFH Chapter 4 and Figure 4-14 for information regarding bearing capacity and foundation properties.

[2]Crushed Stone: 100% passing 3/4” sieve and 10% maximum passing the #200 sieve.

[3]Graded Rock: 100% passing the base course thickness dimension and a maximum of 10% passing the 3/4” sieve. All sizes between the limits shown on the drawings are to be represented.

[4]Reinforcing and control joint spacing according to Subgrade Drag Theory Design as found in ACI 360, Design of Slabs on Grade, or Engineering Field Handbook (EFH), Chapter 17.

[5]Option G is the only option that can be used where the potential for groundwater contamination is the resource concern.

- Option G requires deformed steel reinforcing bars and control joint spacing according to Subgrade Drag Theory Design.
- Option G requires the installation of embedded waterstops at all control, construction, and isolation joints.
- Waterstop to be in accordance with NRCS Wisconsin Construction Specification 4, Conrete.
- Maximum wheel load of 5000 pounds at spacing of 8 feet or to be designed using ACI 360, Design of Slabs on Grade.

SUBSURFACE DRAIN

(Feet)

Code 606

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A conduit installed beneath the ground surface to collect and/or convey excess water.

II. Purpose

This practice may be applied as part of a resource management system to achieve one or more of the following purposes.

- Remove or distribute excessive soil water.
- Remove salts and other contaminants from the soil profile.

III. Conditions Where Practice Applies

This standard applies to agricultural land where a shallow water table exists and where a subsurface drainage system can mitigate the following adverse conditions caused by excessive soil moisture.

- Poor health, vigor and productivity of plants.
- Poor field trafficability.
- Accumulation of salts in the root zone.
- Health risk and livestock stress due to pests such as flukes, flies, or mosquitoes.
- Wet soil conditions around farmsteads, structures, and roadways.

This standard also applies where collected excess water can be distributed through a subsurface water utilization or treatment area.

IV. Federal, Tribal, State, and Local Laws

Users of this standard should be aware of potentially applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing subsurface drains. This standard does not contain the text of federal, tribal, state, or local laws.

V. Criteria

The following criteria apply to all purposes.

A. Capacity

Design capacity shall be based on the following, as applicable.

1. Application of a locally proven drainage coefficient for the acreage drained. The minimum coefficients are shown in Tables 1 and 2.

Table 1
Drainage Coefficients
(No Open Inlets)

Soil	Field Crops (inches)	Truck Crops (inches)
Mineral	⅜ to ½	½ to ¾
Organic	½ to ¾	¾ to 1½

The condition in Table 1 assumes that surface drainage is adequate. The selected drainage coefficient applies to the entire area being drained.

Table 2
Drainage Coefficients
(Surface Inlets in Subsurface Drains)

Soil	Field Crops		Truck Crops	
	Blind Inlets (inches)	Open Inlets (inches)	Blind Inlets (inches	Open Inlets (inches)
Mineral	½ to ¾	½ to 1	¾ to 1	1 to 1½
Organic	½ to 1	½ to 1½	¾ to 2	2 to 4

Note: A ½-inch coefficient may be used if the organic soil occurs only as a small pocket in the vicinity of the inlet.

The selected drainage coefficient from Table 2 will apply to the entire watershed contributing runoff to the surface inlet, except where only a small amount of runoff will be impounded at the location of the inlet with the remainder flowing away in a confined channel. For the latter case, the drain (tile) shall be large enough to remove the impounded water in 24 hours, plus providing additional capacity for the

required internal drainage. Blind inlets should only be used in areas where surface drainage will handle most of the surface water.

2. Yield of groundwater based on the expected deep percolation of irrigation water from the overlying fields.

3. Comparison of the site with other similar sites where subsurface drain yields have been measured.

4. Measurement of the rate of subsurface flow at the site during a period of adverse weather and groundwater conditions.

5. Application of Darcy's law to lateral or artesian subsurface flow.

6. Contributions from surface inlets based on hydrologic analysis or flow measurements.

B. Size

The size of subsurface drains shall be computed by applying Manning's formula, using roughness coefficients recommended by the manufacturer of the conduit. The size shall be based on the maximum design flow rate and computed by using one of the following assumptions:

1. The hydraulic gradeline parallel to the bottom grade of the subsurface drain with the conduit flowing full at design flow (normal condition, no internal pressure).

2. The conduit flowing partly full where a steep grade or other conditions require excess capacity.

3. The conduit flowing under pressure with hydraulic grade line set by site conditions, which differs from the bottom grade of the subsurface drain.

For assumptions 1 or 2 above, the minimum size of subsurface drains may be determined using the drainage charts in the NRCS National Engineering Handbook (NEH) Part 650, Engineering Field Handbook, Chapter 14.

All subsurface drains shall have a nominal diameter that equals or exceeds 3 inches.

C. Internal Hydraulic Pressure

Drains are normally designed to flow with no internal pressure, and the flow is normally classified as open channel. The design internal pressure of drains shall not exceed the limits recommended by the manufacturer of the conduit.

D. Horizontal Alignment

A change in horizontal direction of the subsurface drain shall be made by one of the following methods:

1. The use of manufactured fittings.

2. The use of junction boxes or manholes.

3. A gradual curve of the drain trench on a radius that can be followed by the trenching machine while maintaining grade.

E. Location, Depth, and Spacing

The location, depth, and spacing of the subsurface drain shall be based on site conditions including soils, topography, groundwater conditions, crops, land use, outlets, saline or sodic conditions, and proximity to wetlands.

The minimum depth of cover over subsurface drains may exclude sections of conduit near the outlet or through minor depressions, providing these sections of conduit are not subject to damage by frost action or equipment travel.

Continuous pipe shall be used where it is not feasible to obtain cover as specified, such as where drain lines cross waterways, or roads, the outlet end of mains, or near structures. The continuous pipe shall be of sufficient strength and durability to withstand expected loadings and weathering.

In mineral soils, the minimum depth of cover over subsurface drains shall be 2.0 feet.

In organic soils, the minimum depth of cover after initial subsidence shall be 3.0 feet. If water control structures are installed and managed to limit oxidation and subsidence of the soil, the minimum depth of cover may be reduced to 2.5 feet.

For flexible conduits, maximum burial depths shall be based on manufacturer's recommendations for the site conditions, or based on a site-specific engineering design consistent with methods in NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits.

For computation of maximum allowable loads on subsurface drains of all materials, use the trench and bedding conditions specified and the compressive strength of the conduit. The design load on the conduit shall be based on a combination of equipment loads, trench loads, and road traffic as applicable.

Equipment loads shall be based on the maximum expected wheel loads for the equipment to be used, the minimum height of cover over the conduit, and the trench width.

Equipment loads on the conduit may be neglected when the depth of cover exceeds 6 feet. Trench loads shall be based on the type of backfill over the conduit, the width of the trench, and the unit weight of the backfill material.

F. Minimum Velocity and Grade

In areas where sedimentation is not a hazard, minimum grades shall be based on site conditions and a velocity of not less than 0.5 feet per second. If a sedimentation hazard exists, a velocity of not less than 1.4 feet per second shall be used to establish the minimum grades. Otherwise, provisions shall be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps, or by periodically cleaning the lines with high-pressure jetting systems or cleaning solutions.

G. Maximum Velocity

Design velocities for perforated or open joint pipe shall not exceed those given in Table 3, unless special protective measures are installed. Design velocities with protective measures shall not exceed manufacturer's recommended limits.

Table 3
Maximum Flow Velocities by Soil Texture

Soil Texture	Velocity (ft./sec.)
Sand and sandy loam Muck (sapric)	3.5
Silt and silt loam Mucky peat (hemic)	5.0
Silty clay loam	6.0
Clay and clay loam Peat (fibric)	7.0
Coarse sand or gravel	9.0

On sites where topographic conditions require drain placement on steep grades and design velocities greater than indicated in Table 3, special measures shall be used to protect the conduit or surrounding soil.

Protective measures for high velocities shall include one or more of the following, as appropriate:

1. Enclose continuous perforated pipe or tubing with fabric type filter material or properly graded sand and gravel.

2. Use non-perforated continuous conduit or a watertight pipe, and sealed joints.

3. Place the conduit in a sand and gravel envelope, or initial backfill with the least erodible soil available.

4. Select rigid butt end pipe or tile with straight smooth sections and square ends to obtain tight fitting joints.

5. Wrap open joints of the conduit with tar-impregnated paper, burlap, or special fabric-type filter material.

6. Install larger diameter drain conduit in the steep area to help assure a hydraulic grade line parallel with the conduit grade.

7. Install open air risers for air release or entry at the beginning and downstream end of the high velocity section.

Releases from drainage water management structures shall not cause flow velocities in perforated or open joint drains to exceed allowable velocities in Table 3, unless protective measures are installed.

H. Thrust Control

Follow pipe manufacturer's recommendations for thrust control or anchoring, where the following conditions exist.

1. Axial forces that tend to move the pipe down steep slopes.

2. Thrust forces from abrupt changes in pipeline grade or horizontal alignment, which exceed soil bearing strength.

3. Reductions in pipe size.

In the absence of manufacturer's data, thrust blocks shall be designed in accordance with NEH, Part 636, Chapter 52, Structural Design of Flexible Conduits.

I. Outlets

Drainage outlets shall be adequate for the quantity and quality of water to be discharged. Sinkholes and wells are not to be used as outlets.

Outlets to surface water shall be designed to operate without submergence under normal conditions.

For discharge to streams or channels, the outlet invert shall be located above the elevation of normal flow and at least 1.0 foot above the channel bottom.

Outlets shall be protected against erosion and undermining of the conduit, entry of tree roots, damaging periods of submergence, and entry of rodents or other animals into the subsurface drain.

A continuous section of pipe without open joints or perforations, and with stiffness necessary to withstand expected loads, shall be used at the outlet end of the drain line. Minimum lengths for the outlet section of conduit are provided in Table 4. Single-wall Corrugated Plastic Pipe is not suitable for the section that outlets into a ditch or channel.

For outlets into sumps, the discharge elevation shall be located above the elevation at which pumping is initiated.

Table 4
Minimum Length of Outlet Pipe Sections

Pipe Diameter (in.)	Min. Section Length (ft.)
8 and smaller	10
Larger than 8	20

The use and installation of outlet pipe shall conform to the following requirements:

1. If burning vegetation on the outlet ditch bank is likely to create a fire hazard, the material from which the pipe is fabricated must be fireproof.

2. At least two-thirds of the pipe section shall be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch side slope, or the side slope shall be protected from erosion.

3. If ice or floating debris may damage the outlet pipe, the outlet shall be recessed to the extent that the cantilevered part of the pipe will be protected from the current of flow in the ditch or channel.

4. Headwalls used for subsurface drain outlets must be adequate in strength and design to avoid washouts and other failures.

J. Protection from Biological and Mineral Clogging

Drains in certain soils are subject to clogging of drain perforations by bacterial action in association with ferrous iron, manganese, or sulfides. Iron ochre can clog drain openings and can seal manufactured (fabric) filters. Manganese deposits and sulfides can clog drain openings.

Where bacterial activity is expected to lead to clogging of drains, access points for cleaning the drain lines shall be provided.

Where possible, outlet individual drains to an open ditch to isolate localized areas of contamination and to limit the translocation of contamination throughout the system.

K. Protection From Root Clogging

Problems may occur where drains are in close proximity to perennial vegetation. Drain clogging may result from root penetration by water-loving trees, such as willow, cottonwood, elm, soft maple, some shrubs, grasses, and deep-rooted perennial crops growing near subsurface drains.

The following steps may reduce the incidence of root intrusion:

1. Install a continuous section of non-perforated pipe or tubing with sealed joints, through the root zone.

2. Remove water-loving trees for a distance of at least 100 feet on each side of the drain, and locate drains a distance of 50 feet or more from non-crop tree species.

3. Provide for intermittent submergence of the drain to limit rooting depth by installing a structure for water control (e.g., an inline weir with adjustable crest) that allows for raising the elevation of the drain outlet.

L. Water Quality

Septic systems shall not be directly connected to the subsurface drainage system, nor shall animal waste be directly introduced into the subsurface drainage system.

M. Materials

Subsurface drains include flexible conduits of plastic, bituminized fiber, or metal; rigid conduits of vitrified clay or concrete, or other materials of acceptable quality.

The conduit shall meet strength and durability requirements for the site. All conduits shall meet or exceed the minimum requirements of the appropriate specifications published by the American Society for Testing and Materials (ASTM), American Association of State Highway Transportation Officials (AASHTO), or the American Water Works Association (AWWA); and the minimum requirements indicated in NRCS FOTG Section IV, Wisconsin Construction Specification 44, Corrugated Polyethylene Tubing.

N. Foundation

If soft or yielding foundations are encountered, the conduits shall be stabilized and protected from settlement. The following methods are acceptable for the stabilization of yielding foundations.

1. Remove the unstable material and provide a stable bedding of granular envelope or filter material.

2. Provide continuous cradle support for the conduit through the unstable section.

3. Bridge unstable areas using long sections of conduit having adequate strength and stiffness to ensure satisfactory subsurface drain performance.

4. Place conduit on a flat, treated plank. This method shall not be used for flexible (e.g., corrugated plastic pipe) without proper bedding between the plank and conduit.

O. Filters and Filter Material

Filters shall be used around conduits, as needed, to prevent movement of the surrounding soil material into the conduit. The need for a filter shall be determined by the characteristics of the surrounding soil material, site conditions, and the velocity of flow in the conduit. A suitable filter shall be used if any of the following conditions exist.

1. Local experience with soil conditions indicates a need.

2. Soil materials surrounding the conduit are dispersed clays, silts with a Plasticity Index less than 7, or fine sands with a Plasticity Index less than 7.

3. The soil is subject to cracking by desiccation.

4. The method of installation may result in inadequate consolidation between the conduit and backfill material.

If a sand-gravel filter is specified, the filter gradation shall be based designed in accordance with NEH, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters.

Specified filter material must completely encase the conduit such that all openings are covered with at least 3 inches of filter material, except where the top of the conduit and side filter material are to be covered by a sheet of plastic or similar impervious material to reduce the quantity of filter material required. In all cases, the resulting flow pattern through filter material shall be a minimum of 3 inches in length.

Geotextile filter materials may be used, provided that the effective opening size, strength, durability, and permeability are adequate to prevent soil movement into the drain throughout the expected life of the system. Geotextile filter material shall not be used where the silt content of the soil exceeds 40 percent.

P. Envelopes and Envelope Material

Envelopes shall be used around subsurface drains if needed for proper conduit bedding or to improve flow characteristics into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but must not contain materials that will cause an accumulation of sediment in the conduit, or materials that will render the envelope unsuitable for bedding of the conduit.

Envelope materials shall consist of sand-gravel, organic, or similar material. One hundred percent of sand-gravel envelope materials shall all pass a 1.5-inch sieve; not more than 30 percent shall pass a Number 60 sieve; and not more than 5 percent shall pass the Number 200 sieve.

Organic or other compressible envelope materials shall not be used below the centerline of flexible conduits. All organic or other compressible materials shall be of a type that will not readily decompose.

Q. Placement and Bedding

Placement and bedding requirements apply to both excavation trenching and plow type installations.

Place the conduit on a firm foundation to ensure proper alignment.

Conduits shall not be placed on exposed rock, or on stones greater than 1½ inches for conduits 6 inches or larger in diameter, or on stones greater than ¾ inch for conduit less than 6 inches in diameter. Where site conditions do not meet this requirement, the trench must be over-excavated a minimum of 6 inches and refilled to grade with a suitable bedding material.

If installation will be below a water table or where unstable soils are present, special equipment, installation procedures, or bedding materials may be needed. These special requirements may also be necessary to prevent soil movement into the drain or plugging of the envelope if installation will be made in materials such as soil slurries.

For the installation of corrugated plastic pipe with diameters of 8 inches or less, one of the following bedding methods shall be specified.

1. A shaped groove providing an angle of support of 90 degrees or greater shall be provided in the bottom of the trench for tubing support and alignment.

2. A sand-gravel envelope, at least 3 inches thick, to provide support.

3. Compacted bedding material beside and to 3 inches above the conduit.

For the installation of corrugated plastic pipe wit diameters larger than 8 inches, the same bedding requirements shall be met except that a semi-circular or trapezoidal groove shaped to fit the conduit with a support angle of 120 degrees will be used rather than a V-shaped groove.

For rigid conduits installed in a trench, the same requirements shall be met except that a groove or notch is not required. For trench installations where a sand-gravel or a compacted bedding is not specified, the initial backfill for the conduit shall be selected material containing no hard objects (e.g., rocks or consolidated chunks of soil) larger than 1.5 inches in diameter. Initial backfill shall be carried to a minimum of 3 inches above the conduit.

R. Auxiliary Structures and Protection

The capacity of any structure installed in the drain line shall be no less than that of the line or lines feeding into or through them.

Structures for water table management, with provisions to elevate the outlet and allow submergence of the upstream drain, shall meet

applicable design criteria in Wisconsin NRCS FOTG Conservation Practice Standards 587, Structure for Water Control, and 554, Drainage Water Management.

If the drain system is to include underground outlets, the capacity of the surface water inlet shall not be greater than the maximum design flow in the downstream drain line or lines. Covers or trash racks shall be used to ensure that no foreign materials are allowed in the drain lines. Inlets shall be protected from entry of animals or debris. If sediment may pose a problem, sediment traps shall be installed.

The capacity of a relief well system shall be based on the flow from the aquifer, the well spacing, and other site conditions, and shall be adequate to lower the artesian water head to the desired level. Relief wells shall not be less than 4 inches in diameter.

Junction boxes, manholes, catch basins, and sand traps must be accessible for maintenance. A clear opening of not less than 2.0 feet will be provided in either circular or rectangular structures.

The drain system shall be protected against turbulence created near outlets, surface inlets, or similar structures. Continuous non-perforated or closed-joint pipe shall be used in drain lines adjoining the structure where excessive velocities will occur.

Junction boxes shall be installed where three or more lines join or if two lines join at different elevations. If the junction box is buried, a solid cover should be used, and the junction box should have a minimum of 1.5 feet of soil cover.

If not connected to a structure, the upper end of each subsurface drain line will be closed with a tight-fitting cap or plug of the same material as the conduit, or other durable materials.

Watertight conduits designed to withstand the expected loads shall be used where subsurface drains cross under irrigation canals, ditches, or other structures.

VI. Considerations

When planning, designing, and installing this practice, the following items should be considered.

- Protection of shallow drains, auxiliary structures, and outlets from damage due to freezing and thawing.
- Proper surface drainage to reduce the required intensity of the subsurface drainage system.
- Designs that incorporate drainage water management practices (or facilitate its future incorporation) to reduce nutrient loading of receiving waters.
- Drainage laterals oriented along elevation contours to improve the effectiveness of drainage water management structures.
- The effects of drainage systems on runoff volume, seepage, and the availability of soil water needed for plant growth.
- Confirmation of soil survey information with site investigation, including auguring and shallow excavations to identify soil profile hydraulic characteristics, soil texture layering, water table depth, etc.
- The effects of drainage systems on the hydrology of adjacent lands.
- Subsoiling or ripping of soils with contrasting texture layers to improve internal drainage.
- Installations in dry soil profile to minimize problems of trench stability, conduit alignment, and soil movement into the drain.
- The effects to surface water quality.
- Use of temporary flow blocking devices to reduce risk of drain water contamination from surface applications of manure.

VII. Plans and Specifications

Plans and specifications for installing subsurface drains shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

At a minimum, plans specifications shall include, as applicable: location of drainage system; wetland delineation(s); conduit lengths, grades, sizes, and type of materials; structure locations, dimensions, and elevations; outlet locations, elevations, and

protection required; and normal water level elevations in outlet ditches or streams.

VIII. Operation and Maintenance

The Operation and Maintenance (O&M) Plan shall provide specific instructions for operating and maintaining the system to insure proper function as designed. At a minimum, the O&M Plan shall address:

- Necessary periodic inspection and prompt repair of system components (e.g., structures for water control, underground outlets, vents, drain outlets, trash and rodent guards).

- Winterization protection from freezing conditions for drainage systems in cold climates.

IX. References

USDA, NRCS, National Engineering Handbook, Part 624, Chapter 4, Subsurface Drainage.

USDA, NRCS, National Engineering Handbook, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters.

USDA, NRCS, National Engineering Handbook, Part 636, Chapter 52, Structural Design of Flexible Conduits.

USDA, NRCS, Wisconsin Field Office Technical Guide, Section IV, Conservation Practice Standards and Specifications.

WASTE TRANSFER

(No.)

Code 634

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

A system using structures, conduits or equipment to convey byproducts (wastes) from agricultural operations to points of usage.

II. Purposes

To transfer waste (manure, *manure processing derivatives*[1], *contaminated runoff*, and *wastewater*, which includes milking center waste, *leachate* from feed holding areas, and similar waste materials) in a manner which safeguards the environment. It includes transfer through a *hopper, reception structure*, a pump, *channel*, or permanently installed conduit to:

- A waste storage facility,
- A waste treatment facility,
- A wastewater treatment system,
- A loading area,
- Cropland.

III. Conditions Where Practice Applies

The waste transfer component is part of a planned agricultural waste management or comprehensive nutrient management system.

This practice standard applies where manure and other waste is generated by livestock production or processing, and a permanently installed conveyance system is necessary to transfer material from the source to a storage facility, treatment facility or system, loading area, or cropland. This includes moving nutrients from one geographical area with excess nutrients to a geographical area that can utilize the nutrients in an acceptable manner.

This practice standard does not apply to conveyance systems using equipment or mechanisms such as *gutters*, barn cleaners, alley scrapers, or belts for moving manure in the housing facility to the manure transfer system.

This practice standard does not apply to transfer by vehicles or temporary surface pipe or hoses from the storage facility, treatment facility or system, or loading area to the field or another storage facility.

IV. Federal, Tribal, State and Local Laws

Waste transfer systems shall comply with all federal, tribal, state and local laws, rules or regulations or permit requirements governing waste transfer. The operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state or local laws.

V. Criteria

The following minimum criteria shall apply to all waste transfer designs.

A. General Criteria

1. Management Assessment

A management assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed with the owner/operator to explore options and to determine the purpose of transfer components, available resources, manure handling practices, and waste characteristics.

The management assessment shall address the following:

a. Waste Characterization.

   1) Sources, volumes and consistency of manure, contaminated runoff, manure processing derivatives, leachate, wastewater, and other inputs to the waste transfer system.

   2) Animal types.

   3) Bedding types and quantity.

b. Waste handling, transfer methods and duration.

c. Facility waste removal methods.

d. Access needs and limitations.

[1] Words in the standard that are shown in italics are described in VIII. Definitions. The words are italicized the first time they are used in the text.

e. Safety needs.

f. Labor and equipment needs.

g. Odor production concerns and control strategies.

h. Aesthetics and animal health.

i. Provisions for facility expansion.

2. Site Assessment

A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of a proposed waste transfer system. The assessment shall include input from the owner/operator. The site assessment shall include the following.

a. Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, wells, springs, floodplains, surface waters, surface drains, drain tile, utilities, overhead lines, *cultural resources*, and wetlands.

b. Subsurface investigations for reception structures, channels and transfer pipes in the *animal production area* shall be located such that no portion of the structure, channel or pipe is greater than 100 feet from a subsurface investigation point. The investigation shall extend to a minimum depth to ensure required separation distances for the proposed component are achieved.

c. Additional soil investigations shall be conducted if there are substantial variations within or between the soil investigations that may affect the design.

d. Subsurface investigation logs shall include:

1) Soil layers described with respect to thickness, texture using the Unified Soil Classification System (USCS), Munsell color, presence and color of redoximorphic features (soil mottling), *gleyed soil* and moisture condition.

2) The elevation of *bedrock* and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.

3) The upper elevation of all saturated layers encountered shall be recorded in the field.

e. Subsurface investigations shall include a narrative describing the design limitations that have been derived from the soils data.

3. Separation from Subsurface Saturation or Bedrock

The separation is determined to be the closest distance from any point on the inside surface of the component to the feature from which separation is required.

The definition of subsurface saturation is not intended for application in any context other than to protect components installed from hydrostatic loadings.

a. For the purposes of this standard, factors used to identify subsurface saturation shall include observed saturation, gleyed soil, gray mottles, and soil color in conjunction with nearby surface water features. The highest subsurface saturation elevation identified in a test pit/soil boring will be identified by any of the following soil properties.

1) Free water or wet soil identified by glistening, due to the slow release of water.

2) Gleyed soil, that may extend uninterrupted from an observed free water surface.

3) The presence of distinct gray redoximorphic features with a chroma of 2 or less based on Munsell color charts.

4) Depleted matrices having a value of 4 or more and chroma 2 or less based on Munsell color charts. In some cases soil parent materials have a natural color of 2 chroma or less or gleyed color that is not due to saturation. In these cases other indicators may be used: landscape

position, elevation or soils in relation to nearby water features.

b. In soils not conducive to mottling, such as sand, the subsurface saturation elevation shall be established by evaluating the soil morphology of the soil profile. Other indicators that may be considered in making the determination are the position of the soil in the landscape, topography, nearby wetlands and well construction logs.

c. Subsurface saturation, if encountered, shall not be drained (or have water-bearing layers removed) except as described for *perched conditions*. Perched conditions may be drained or water-bearing materials removed to achieve separation distances in the tables and relieve hydrostatic loads. Documentation to demonstrate that subsurface saturation is perched and of drainable extent or its effects otherwise eliminated shall be included in the site assessment. All *drainage systems* shall drain by gravity. The effect of temporary tailwater on the component and the effects of outletting to perennial and intermittent waterways shall be evaluated. A drainage system shall be located around the outside perimeter of the component footprint and drain to a surface outlet.

d. If the site assessment indicates artesian features, a hydrogeologic and geotechnical evaluation of the site shall be completed to determine the site suitability for in-ground components.

e. Excavation of bedrock is permitted to achieve the required separation distance as specified in the tables. Bedrock shall not be removed by blasting. The exposed bedrock surface shall be evaluated to ensure a structurally sound base. Fractures or voids shall be treated to prevent migration of soil material. The surface of excavated bedrock shall have a positive grade, minimum of 1 percent, under and away from the component, as to prevent any significant ponding on the rock surface unless otherwise stated in specific criteria sections. If bedrock is excavated, the material placed between the component and the bedrock shall have a minimum of 20% passing the #200 sieve.

4. Flood Prone Areas

a. Reception structures, channels and hoppers located in *flood prone areas* shall be protected from inundation, structural damage and instability from the maximum water elevation resulting from the 25-year, 24-hour rainfall event.

b. Waste transfer components located within the maximum water elevation resulting from the 25-year, 24-hour rainfall event, shall be designed for additional loadings such as hydrostatic pressures and buoyancy/uplift. These systems shall also be evaluated for additional protections such as automatic shutoff systems, backflow prevention valves or check valves, watertight connections, main power disconnects, submersible type splices on electrical lines, etc. Any vents, power supplies, and automatic or manual shutoff controls shall be located at or above the maximum water elevation resulting from the 25-year, 24-hour rainfall event so that access is possible.

5**. Safety**

The system design shall identify and minimize the hazards to animals and people during construction and operation. Waste transfer designs may create *confined spaces*, which can pose significant hazards to people. At a minimum, a design shall include the following.

a. Open structures shall be provided with covers or barriers such as gates, safety fences (see Wisconsin NRCS Field Office Technical Guide, Section IV (WI FOTG), Conservation Practice Standard 382, Fence), etc., to restrict access of animals or people. Include warning signs as necessary.

b. Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.4, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP393.3, Manure Storages, shall be the minimum used. For vehicles or equipment in excess of 20,000 pounds

gross vehicle weight, the actual axle load shall be used.

c. In push-off areas, barriers shall be installed to prevent the accidental entry of tractors or other equipment.

d. Warning signs shall be provided for waste transfer systems as necessary to warn of the danger of entry and to reduce the risk of explosion, poisoning, or asphyxiation. Appropriate signage shall be visibly located at all access points.

e. Ventilation of enclosed areas shall be provided as necessary to reduce the risk of explosion and asphyxiation.

f. Waste transfer lines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices where necessary to control gas entry into buildings.

g. A minimum of one in-line manual valve in the transfer pipe, located as close to the storage facility as practical, shall be installed when the top of the storage facility is higher than the top of the transfer structure. An in-line valve is not required if the transfer pipe does not penetrate the liner and terminates at an elevation above the top of the storage facility, thus providing an air gap.

h. Confined spaces where human entry may occur shall be designed and operated in compliance with the provisions contained in ASABE EP470, Manure Storage Safety. Covered channels and reception structures that require humanly occupied equipment operated in the transfer system for cleaning shall not be utilized because they do not meet this safety standard.

6. Failure Analysis

The overall functionality of the waste transfer system shall be evaluated for possible malfunctions that could lead to a release of the waste transfer system contents outside the normal operational confines of the waste management system. Identified potential failures should be addressed in the design phase, the operation and maintenance plan, and the emergency response plan**.**

7. Construction Plans and Specifications

Construction plans and specifications for installing waste transfer systems shall be in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended purpose, including the maximum design *working pressure* and the *transfer system pressure rating* of each transfer system. Construction plans and specifications shall include a location map, plan view, profiles, cross sections, details and specifications to ensure that the project can be properly constructed.

8. Engineering Design Documentation

Engineering design documentation shall be prepared in compliance with the Design Deliverables in the Wisconsin NRCS Statement of Work for the WI FOTG Standard 634, and shall demonstrate that the criteria in the NRCS practice standard have been met. Design documentation shall include all substantiating data, assumptions, computations and analyses, and the maximum design working pressure and the transfer system pressure rating of each transfer system.

9. Quality Assurance Plan

A quality assurance plan is required that describes the type and frequency of testing, the items requiring inspection, the documentation required, and the qualifications of the person doing the work.

The quality assurance plan shall address the following items:

a. Site and Contact Information.

b. Introduction and Project Description – Narrative Format.

c. Responsibilities of Key Parties.

d. Pre-Construction Meeting.

e. Items Requiring Inspection, Observation, and Testing.

f. As-built Plans and other Certification (Attesting) Documentation.

10. Operation and Maintenance

An Operation and Maintenance (O&M) Plan shall be prepared and reviewed with the landowner and/or operator responsible for the application of this practice. The O&M Plan shall provide specific instructions for proper operation and maintenance of each component of this practice and shall detail the routine maintenance needed to assure the effectiveness and useful life of this practice. The O&M Plan shall be consistent with the purpose of this practice, safety requirements, criteria for design and the Operation and Maintenance Plan in WI FOTG Standard 313, Waste Storage Facility.

At a minimum, the O&M Plan shall include the following items:

a. System information including the general system description, assumed system performance, maximum design working pressure and the transfer system pressure rating of each transfer system.

b. Safety and emergency response including actions to address potential component failures identified in the waste transfer system failure analysis and an emergency response plan for actions needed to address spills and overflows.

c. Operating procedures including: typical operating procedures, procedures for proper start-up and shutdown for the operation of pumped transfer systems and valve operation sequence if applicable.

d. Maintenance items including: scheduled routine maintenance required by the component manufacturer, procedures for cleaning and unplugging pipe, and inspection and maintenance of all safety items.

B. Specific Criteria

1. Reception Structures, Channels, Hoppers, and Pumps

Reception structures, channels, hoppers, and pumps shall meet the following criteria.

a. Joints and appurtenances shall be liquid tight.

b. Separation distances criteria in Table 1 shall be met.

c. Reception structures shall be sized as follows:

1) Reception structures that are part of a manure transfer system.

a) Reception structures not receiving runoff and/or precipitation shall be sized to contain a minimum of one full day's manure production, plus six inches extra depth for safety; or

b) Reception structures receiving runoff and/or precipitation shall be sized to contain a minimum of one full day's manure production, plus six inches extra depth for safety, and the volume of runoff and/or precipitation from a 25-year, 24-hour rainfall event. The increase in storage volume due to runoff and/or precipitation may be reduced if a portion of this runoff and/or precipitation can be safely routed to and contained within the waste management system.

2) Reception structures that are part of a contaminated runoff or wastewater management system.

a) Reception structures not receiving runoff and/or precipitation shall be sized according to the appropriate conservation practice standard and design needs of the system; or

b) Reception structures receiving runoff and/or precipitation shall be sized according to the appropriate conservation practice standard and design needs of the system, plus the volume of runoff and/or precipitation from a 25-year, 24-hour rainfall event. The increase in storage volume due to runoff and/or precipitation may be reduced if a portion of this

runoff and/or precipitation can be safely routed to and contained within the waste management system.

d. Openings to structures to receive material from alley scrape collection shall be a minimum of 9 square feet with one dimension no smaller than 4 feet. The opening shall be equipped with a grate designed to support the anticipated loads, or otherwise protected to prevent accidental entry.

e. Cast in place reception structures and channels shall be designed for static and dynamic loading, including uplift (buoyancy). Reception structures and channels shall be designed to withstand soil and hydrostatic loading in accordance with WI FOTG Standard 313, Waste Storage Facility. Covers, when needed, shall be designed to support the anticipated dead and live loads.

f. Prefabricated reception structures and channels used to transfer manure and manure processing derivatives shall be designed according to the structural and soil criteria in WI FOTG Standard 313, Waste Storage Facility.

g. Prefabricated reception structures used to transfer only wastewater and/or contaminated runoff are not required to meet the structural and soil criteria in WI FOTG Standard 313, Waste Storage Facility, but shall meet, at a minimum, the following requirements:

The structure shall be currently listed in the Wisconsin Department of Safety and Professional Services (DSPS), Safety and Building Division, Plumbing Products Database.

1) The structure shall comply with all stipulations listed in the Wisconsin DSPS approval that relate to liquid tightness and/or structural strength.

2) The structure shall be located a minimum of 15 feet from established or planned roadways, or designed for anticipated loads.

3) No structural modifications to prefabricated structures, such as pump attachments, shall be made unless approved in writing by the manufacturer.

h. Pre-manufactured manholes shall conform to the criteria in ASTM C478 and the base section shall have the riser wall and base slab cast monolithically as a single unit.

i. Pumps shall be sized to transfer waste at the required system head and flow rate. The type of pump shall be based on the consistency of the waste and the type of bedding used, if applicable. Requirements for pump installations, including connecting appurtenances, shall be based on manufacturer's recommendations. Pumps installed for transfer shall meet the requirements of WI FOTG Standard 533, Pumping Plant.

l. When penetrating waste storage liners, the performance and integrity of the liner shall be maintained. All penetrations and restraints shall meet the criteria in WI FOTG Construction Specification 634, Waste Transfer (Spec. 634).

m. When solid/liquid waste separation is planned, a filtration or screening device, settling tank, settling basin, or settling channel used to separate a portion of solids from the manure or liquid waste stream shall be designed in accordance with WI FOTG Standard 632, Solid/Liquid Waste Separation Facility.

Table 1
Separation Distances for Reception Structures Hoppers, Channels, Pumps, and Pipes

Transfer Components	Bottom of Pump, Floor Surface, or Pipe Invert Relative to Bedrock	Bottom of Pump, Floor Surface, or Pipe Invert Relative to Subsurface Saturation	Well, Spring, and Reservoir Separation Distance [Note 1]
Pumps			
Pumps encased in concrete	≥ 6 inches	Bottom of pump maximum depth into saturation shall be 2 feet	≥ 50 feet
Pumps housed in a drywell [Note 2]	≥ 6 inches	Floor may be at the subsurface saturation level	≥ 50 feet
Reception Structures and Hoppers			
Capacity < 6,000 gallons	≥ 1 foot	Floor may be at the subsurface saturation level[Note 3]	≥ 50 feet
Capacity ≥ 6,000 gallons	≥ 2 feet	≥ 2 feet (≥1 foot for sumps)[Note 3]	≥ 100 feet
Channels			
(≥ 2 foot depth)	≥ 2 feet	≥ 2 feet (≥1 foot for sumps)[Note 3]	≥ 100 feet
Pipes			
All	≥ 6 inches	No restrictions	≥ 25 feet

[Note 1] Well, spring, and reservoir separation distances are in accordance with NR 812, Well Construction and Pump Installation. Items not listed in the table shall also be in accordance with NR 812. DNR-permitted animal feeding operations need to follow the 250-foot well separation distance requirements of NR 243.

[Note 2] Drywells contain pump hardware and are not intended to contain waste.

[Note 3] Separation distances from subsurface saturation is not required if the reception structure, hopper, or channel is designed to withstand anticipated hydrostatic loads and uplift (buoyancy).

2. Pipes

This applies to systems using pipes to carry waste to reception structures, waste storage facilities, waste treatment facilities, wastewater treatment systems, loading areas or cropland. Transfer pipe and severe service transfer pipe shall meet the following criteria.

a. Transfer Pipe

Transfer pipes shall meet the following criteria:

1) Design of transfer pipe systems shall be in accordance with sound engineering principles taking into account the static and dynamic loads on the pipe, working pressure, transfer system pressure rating, site conditions, required capacity, and other applicable design factors. Pipe shall be designed based on the properties of the material to be transferred and shall convey the required flow without plugging. Working pressure shall not exceed 72% of the transfer system pressure rating.

2) Flow velocity for pumped systems, other than pumps which produce pulsating flow, shall be between 3 feet per second and 6 feet per second to minimize settling of solids. Flow velocity may exceed 6 feet per second if the transfer system design takes into account requirements for joints and other appurtenances that accommodate the velocity and any potential loss of pipe integrity due to internal erosion by the materials being transported.

3) Pipe exposed to sunlight shall be made of materials, or otherwise protected, to withstand ultraviolet radiation throughout the intended life of the pipe.

4) Pipe at risk to being damaged shall be identified by fences or markers placed along the pipe.

5) Pipe shall be installed in accordance with the requirements of the Wisconsin FOTG Specification 634, or equivalent specification. All joints, couplings and appurtenances shall be liquid tight in accordance with the manufacturer's specifications and Wisconsin FOTG Specification 634.

6) Pipe shall meet the criteria in Wisconsin FOTG Specification 634. Pipe of equivalent strength, durability, and liquid tightness are acceptable.

7) Pipe and appurtenances shall be compatible with the working pressure of the system. Air and water pressures used to clear the pipe shall not exceed the transfer system pressure rating. A warning sign shall be placed on all risers indicating the transfer system pressure rating. Pressure pipe shall be matched to the pump connected to it, and pipe working pressures shall be no less than the *pump shut-off head;* otherwise, pressure relief (designed per Section V.B.2.b.(2) below) shall be provided near the pump.

8) Thrust control for all buried pressure pipe 4 inches and larger in diameter shall be provided at all angled fittings and valves, and be designed in accordance with standard engineering practices.

9) Pipe penetrating waste storage liners, reception tanks, or channels shall be installed so that the performance and integrity of the liner is maintained. Pipes shall be continuous through walls. The section of pipe that penetrates the liner of a waste storage facility shall be a minimum of 10 feet in length and shall be supported with a cast-in-place concrete restraint. All joints within 25 feet of where the pipe penetrates the inside surface of the waste storage facility (measured along the length of the pipe) shall have a mechanical and/or concrete restraint. All penetrations and restraints shall meet the criteria in Wisconsin FOTG Specification 634.

10) Pipe may be installed in any location within the soil profile regardless of subsurface saturation or bedrock elevations. Pipe subjected to hydrostatic forces shall be protected from uplift. Pipe shall have at least 6 inches of bedding providing separation from bedrock. Excavation of bedrock is acceptable. Storage structure liners shall be protected from hydrostatic pressures that may be caused by preferential flow paths along installed pipe.

11) If cold weather operation is planned, transfer pipe shall be: insulated, heated, buried below anticipated frost depth, constructed of freeze tolerant material, or installed such that it can be evacuated after each use by draining or using compressed air. Buried pipe shall be protected from freezing with either a minimum of 4 feet of soil cover or an equivalent amount of soil and insulation, unless the pipe is evacuated after each use.

12) *Clean-out access* shall be provided at a maximum interval of 150 feet along the pipe length, or a maximum interval of 300 feet along the pipe length if bi-directional clean-outs are used, to allow for removal of settled solids or obstructions.

    A minimum of one in-line manual valve in the pipe, located as close to the storage facility as practical shall be provided if any clean-out riser is lower than the top of the waste storage structure.

    Clean-out access is not required for pipes transferring wastewater, contaminated runoff, and similar wastes with a low solids content or pipes used for transfer to cropland for application. A method to clean these pipes in the event of plugging shall be incorporated into the design and described in the Operation and Maintenance Plan.

13) Pipe shall be installed with appropriate backflow prevention devices to prevent contamination of private or public water supply distribution systems and groundwater.

14) Air vents and vacuum relief valves shall be provided where necessary to eliminate air locks, as well as to protect the pipe against negative pressures.

b. Severe Service Transfer Pipe

Severe service transfer pipe includes pressure pipes supplying flush water to gravity flume systems and pipe extending to cropland application. It does not include gravity transfer pipe. In addition to the transfer pipe criteria in V.B.2.a (1)-(12), severe service transfer pipe shall meet the following criteria:

1) A check valve shall be provided near the outlet of each pump except when backflow is incorporated into the design of the transfer system.

2) A pressure relief valve shall be provided near the pump(s) to protect the pipe against pump shut-off head due to a blockage (unless the pump shut-off head is less than the working pressure of the transfer system). A pressure relief valve or properly sized water hammer arrestor shall be provided on the pressure side of shut-off valves to protect against water hammer due to the sudden closing of a valve. Pressure relief valves shall be no smaller than ¼-inch nominal size for each inch of the pipe diameter. Pressure relief valves shall be set to open at a pressure no greater than 5 lb./in^2 above the transfer system working pressure.

3) Air and water pressures used to clear the pipe shall not exceed the transfer system pressure rating. A warning sign shall be placed on all risers indicating the transfer system pressure rating.

4) Pipe shall be pressure tested prior to being placed into service. The test protocol and results shall be included

in the as-built documentation. The pipe shall be tested for leaks in accordance with Wisconsin FOTG Specification 634. Pipeline used for transferring material to an irrigation system shall meet the requirements of WI FOTG Standard 430, Irrigation Water Conveyance, Pipeline.

c. Gravity Transfer System

This criteria applies to systems using pipe to carry waste to reception structures, waste storage facilities, waste treatment facilities, wastewater treatment systems, loading areas or cropland. Gravity transfer pipe and structures shall meet the following criteria.

1) There shall be no gravity outlets used to empty waste storage facilities.

2) There shall be no gravity outlets from transfer systems to load-out areas without secondary containment volume greater than the transfer system capacity.

3) Gravity discharge pipe used for transferring waste from one storage facility to another shall have a minimum of two shut off valves if one facility can release a volume that would exceed the maximum operating level of the receiving facility. The valves shall be located as close to each of the storage facilities as practical. One valve shall be manually operated.

4) Gravity transfer pipe shall follow all previous transfer pipe criteria (V.B.2.a 1)-14)) plus the following additional criteria listed in Table 2.

Table 2
Summary of Criteria for Gravity Transfer Systems

	Slower Flowing Wastes	Faster Flowing Wastes
Description	For wastes that tend to be slower flowing due to bedding, feed, or dryness (typically stanchion barns or thick slurries with higher viscosities).	For wastes that tend to be faster flowing due to additional liquids or lack of bedding (typically free stall barns, veal or hog facilities, and contaminated runoff with lower viscosities).
Minimum Pipe Diameter	24 inches	No minimum diameter
Minimum Head in Gravity Flow Systems (as measured from the Maximum Operating Level (MOL) of the Waste Storage Facility)	Shall be a minimum of 4 feet below the bottom of the barn cleaner, scrape alley, etc., For pipe over 100 feet in length an additional height equal to 1% of the transfer pipe length shall be included.	Liquid or semi-solid wastes shall have a minimum of: • 2 feet below the scrape alley, barn cleaner, channel, etc., and • An additional height equal to 1% of the transfer pipe length Diluted wastes shall have a minimum of: • 1 foot below the scrape alley, barn cleaner, channel, etc., and • An additional height equal to 1% of the transfer pipe length
Minimum Volume of Reception Structure	One full day's manure production. A minimum of one-half a day's manure volume must be between the MOL of the waste storage facility and the bottom of the barn cleaner or scrape alley.	One full day's manure production.
Vent Pipe	A 6-inch diameter minimum vent pipe is required. Install within 10 feet of the reception structure.	A 6-inch diameter minimum vent pipe installed within 10 feet of the reception structure is required for reception structures with knife valves.

VI. Considerations

Considerations include additional design recommendations that are not required criteria, but may be used to enhance, or avoid problems with, the design and function of this practice.

A. Consider the operating space requirements of loading and unloading of equipment in the vicinity of the transfer components.

B. Consider the use of leak detection methods and equipment for monitoring and periodic pressure testing of waste transfer systems.

C. Consider how operating temperatures may affect the *pressure rating* of the pipe.

D. Consider installing thrust control consisting of a cast-in-place thrust block installed at every third joint, or a mechanical joint restraint device installed at every joint for gasketed pipe subjected to pulsating flow.

E. Consider the need for additional check valves, clean-outs, vent risers, knife valves, anti-siphon protection, vacuum relief valves and open air breaks, as appropriate, on all transfer pipe systems.

F. Consider the potential for salt (struvite) deposits in small pipe. Preventative measures may be needed, such as acid washing the pipe to prevent deposits.

G. Consider pressure testing pipe installed in sensitive areas, large daily flow volumes, long flow lengths, high flow pressures, etc.

H. Consider installing permanent aboveground or buried pipe for hoses and temporary pipe that is used on a regular basis to transfer waste.

I. Consider the effects of adding liquid to manure that contains sand bedding. Liquid can enhance sand settling.

J. Consider having gravity pipe follow as direct a route as possible. Risers, such as pre-manufactured manholes, may be used to change direction.

K. Consider installing a clean-out or vent riser within 10 feet of the reception structure, for gravity transfer systems that are not required to have a vent riser in order to reduce the risk of air lock in the pipe.

L. Consider installing a manually operated shut off valve for isolation purposes for gravity discharge pipe used for transferring waste from one structure to another.

M. Consider the use of a wet sump to reduce solids separation within the gravity reception structure.

N. Consider abandonment, relocation, or additional floodproofing for existing reception structures located in flood prone areas. For additional information on floodproofing structures, see "Floodproofing Non-Residential Structures," FEMA 102, May 1986, Federal Emergency Management Agency.

VII. References

USDA, NRCS, Agricultural Waste Management Field Handbook, Part 651.

Wisconsin Department of Safety and Professional Services (DSPS), Safety and Building Division, Plumbing Products Database: http://dsps.wi.gov.

Wisconsin Administrative Code, Department of Natural Resources, Chapter NR 812, Well Construction and Pump Installation.

FEMA, Floodproofing Non-Residential Structures, FEMA 102, May 1986.

USDA, NRCS, National Handbook of Conservation Practices.

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

American Society of Agricultural and Biological Engineers (ASABE), Standard EP470, Manure Storage Safety.

VIII. Definitions

Animal Production Area (V.A.2.b) – Means any part of the livestock operation that is used for the feeding and housing of livestock. This includes the entire animal confinement and feeding area, and any adjacent manure storage areas, raw materials storage areas, and waste containment areas. This does not include pasture and cropland.

Bedrock (V.A.2.d.2)) – The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

Note: Although solid or consolidated bedrock can sometimes be removed with typical excavation

equipment, these materials are included in the above definition.

Channel (II) – A narrow structure, 4 feet or less in width, into which wastes are scraped or flushed for immediate transfer to reception structures, hoppers or waste storage facilities. They include field-fabricated or cast-in-place drop inlet structures incorporated into gravity transfer pipe. They also include existing gutters modified from how they were originally operated and constructed. Channels may include internal mechanical or hydraulic transfer mechanisms.

Clean-out Access (V.B.2.a.12)) –Pipe appurtenances such as air flushing valves, risers, manholes, and accessible openings of pipe into reception structures or storage facilities that allow mechanical cleaning or unplugging of a pipe.

Confined Space (V.A.5) – Confined Space is a space that 1) contains or has the potential to contain a hazardous atmosphere; 2) is large enough and so configured that a person can bodily enter; 3) has limited or restricted means for entry or exit; and 4) is not designed for continuous human occupancy.

Contaminated Runoff (II) – Runoff that has come through or across a barnyard or animal lot or feed storage area. It generally includes the runoff and any manure, sediment, feed, or other material carried in the runoff. It contains lower concentrations of contaminants than leachate from feed or manure.

Cultural Resources (V.A.2.a.) – Cultural resources are the traces of any past activities and accomplishments of people. They include tangible traces such as historic districts, sites, buildings, structures, historical documents and cemeteries. They also include traces of less tangible objects such as dance forms, aspects of folk-life, cultural or religious practices, and some landscapes and vistas.

Flood Prone Areas (V.A.4.a.) – These include areas delineated as floodplains on Federal Emergency Management Agency (FEMA) maps, or local floodplain maps as well as areas along perennial streams (blue lines) shown on the United States Geologic Survey quadrangle sheets that may be subject to out of bank flows.

Gleyed Soil (V.A.2.d.1)) – Soil that has been subject to prolonged saturated conditions, exhibited by gray, blueish gray, greenish gray, dark greenish gray, dark blueish gray as the dominant soil colors. (These colors appear on the Munsell color charts for Gley) Soil color and patterns must be observed immediately upon excavation because air exposure may rapidly transform colors to a mottled pattern of reddish, yellow or orange patches.

Gutters (III) – Existing open troughs within housing facilities that are used to transfer wastes to a reception structure or waste storage facility. Existing gutters modified from how they were originally operated and constructed are considered to be channels.

Hopper (II) – Structure meant solely to feed wastes into a transfer pump. Hoppers larger than 6,000-gallon capacity are defined as reception structures.

Leachate (II) – Concentrated liquid waste which has percolated through or drained by gravity from a pile of manure, manure processing derivative, or animal feed. It contains much higher concentrations of contaminants than contaminated runoff.

Manure Processing Derivatives (II) – The by-products and waste components that are produced as a result of treatment and processing practices. These include, but are not limited to, the following waste components: flush water, separated sand, separated manure solids, precipitated manure sludges, supernatants, digested liquids, composted biosolids, and process waters.

Perched Conditions (V.A.3.c.) – Perched conditions describe a soil moisture regime where saturated soil is located above unsaturated soil.

Pump shut-off head (V.B.2.a.7)) - Maximum pressure a pump can produce. Represented by the highest point on the pump flow curve.

Pressure Rating (VI.D) – Estimated maximum water pressure the pipe is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. Pressure rating is determined by the pipe manufacturer.

Reception Structure (II) – A collection vessel that will hold waste and facilitate its transfer.

Transfer System Pressure Rating (V.A.7) - The lowest pressure rating of any pipe, pipe fittings, and other appurtenances. This is independent of pump shut-off head pressure.

Wastewater (II) – Milkhouse and milking parlor washwater, leachate from feed storage areas, and similar waste materials. Wastewater from holding area is considered manure.

Working Pressure (V.A.7) – The maximum designed operating pressure of the transfer system. Working pressure is a maximum of 72% of the transfer system pressure rating. For pumped systems, this is determined by the shut-off head of the pump and static head.

NRCS Construction Specifications

WISCONSIN CONSTRUCTION SPECIFICATION

1. Clearing

1. SCOPE

The work shall consist of the clearing and disposal of trees, snags, logs, brush, shrubs, stumps, and rubbish from the designated areas.

2. MARKING

The limits of the areas to be cleared will be marked by means of stakes, flags, tree markings, or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about 6 feet above the ground surface.

3. PROTECTION OF EXISTING VEGETATION

Trees and other woody vegetation designated to remain undisturbed shall be protected from damage throughout the entire construction period. Any damage resulting from the Contractor's operations or neglect shall be repaired by the Contractor.

Earthfill, stockpiling of materials, vehicular parking, and excessive foot or vehicular traffic shall not be allowed within the dripline of vegetation designated to remain in place. Vegetation damaged by any of these or similar actions shall be replaced with viable vegetation of the same species.

Any cuts, skins, scrapes, or bruises to the bark of the vegetation shall be carefully trimmed and local nursery accepted procedures used to seal damaged bark.

Any limbs or branches 0.5-inch or larger in diameter that are broken, severed, or otherwise seriously damaged during construction shall be cut off at the base of the damaged limb or branch flush with the adjacent limb or tree trunk.

All roots 1 inch or larger in diameter that are cut, broken, or otherwise severed during construction operations shall have the end smoothly cut perpendicular to the root. Roots exposed during excavation or other operations shall be covered with moist earth and/or backfilled as soon as possible to prevent them from drying.

4. CLEARING

Trees, brush, shrubs, stumps, and other woody growth shall be cleared to a height not exceeding 12 inches above the ground surface. Such growth may be cleared by cutting, pulling, grubbing, or other approved methods.

Trees shall be felled in such a manner as to avoid damage to trees that are to be left standing, existing structures, utilities, and with regard for the safety of persons.

When the designated areas to be cleared include borrow areas and/or areas upon which improvements are to be constructed, the required grubbing of stumps, roots, and other objectionable material in these areas shall be a part of this specification. The grubbing shall consist of the removal of all stumps,

roots of 1 inch in diameter or larger, buried logs, and other objectionable material to a minimum depth of 2 feet below a structure subgrade and 1 foot below an embankment foundation.

5. SITE EROSION CONTROL

Measures shall be installed, or the work performed in a manner that will minimize site erosion, and the production of sediment. Protective measures shall include but are not limited to diversions, waterways, seeding, mulching, sediment basins, and silt fences.

6. DISPOSAL

All materials cleared from the designated areas shall be burned or buried at approved locations or otherwise removed from the site. Buried materials shall be covered with a minimum of 2 feet of earthfill (including any topsoil added for seeding).

The Contractor is responsible for complying with all rules and regulations for disposal at locations away from the construction site or for the burning of cleared materials.

WISCONSIN CONSTRUCTION SPECIFICATION

2. Excavation

1. SCOPE

The work shall consist of the excavation of all materials necessary for the construction of the work.

2. USE OF EXCAVATED MATERIALS

To the extent that they are needed, all suitable materials removed from the specified excavations shall be used in the construction of the required earthfill. The suitability of materials for specific purposes will be determined by the Technician. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

3. DISPOSAL OF WASTE MATERIALS

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the locations shown on the drawings or as approved by the Technician. Waste materials shall not be placed in wetlands.

Material placed in designated waste disposal areas shall be left in a neat and sightly condition and sloped to provide positive drainage. Compaction of the waste materials will not be required unless specified by the construction plans.

Waste material excavated from channels may be deposited in leveled spoilbanks or areas adjacent to the channel work (if permissible). The shape and slopes of the spoilbanks shall be indicated on the drawings or as approved by the Technician. Spoil piles shall be located a minimum of 12 feet from the top of the channel side slope.

Spoil piles or disposal areas shall be protected to minimize site erosion and the production of sediment. Protective measures may include but are not limited to diversions, seeding, mulching, sediment basins, and silt fences.

4. SPECIAL REQUIREMENTS FOR STRUCTURE AND TRENCH EXCAVATION

The required dimensions and side slopes of all structure and trench excavations shall be as shown on the drawings.

Excavation beyond the limits of the specified lines and grades shall be corrected by filling the resulting voids with approved compacted materials.

Excavation for the installation of pipes shall follow the practices contained in the Occupational Safety and Health Administration (OSHA) Subpart P, Excavation, of 29 CFR 1926.650, .651 and .652.

Side slopes shall be excavated or braced to safeguard the work and workers. When bracing or supporting is required, the width of the excavation shall be adjusted to allow for the space occupied by the sheeting, bracing, or other supporting installations. The Contractor shall furnish, place, and subsequently remove such supporting installations.

5. REMOVAL OF WATER

The Contractor shall construct and maintain all necessary cofferdams, channels, flumes, pumping equipment, and/or other temporary diversion and protective work for dewatering the various parts of the work. Foundations, cutoff trenches, and other parts of the work shall be maintained free from water as required for constructing each part of the work. After having served their purpose, all cofferdams and other temporary protective works shall be removed, or leveled to give a sightly appearance and so as not to interfere in any way with the operation, usefulness, or stability of the permanent structure.

6. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fill portions of the permanent works, additional materials shall be obtained from the designated borrow areas.

When shown on the drawings, sediment basins, terraces, diversions, or other measures shall be constructed to protect the borrow areas from erosion and retain sediment within the borrow area.

The upper six (6) inches shall be stripped from all borrow areas. This stripping shall be performed immediately prior to use of the borrow material to reduce the time the area is exposed to erosion. For large borrow areas, only a portion of the area should be stripped at a time. This material shall be redistributed over the area from which it came after borrow excavation is completed.

The extent of excavation and the selection of materials from the borrow area shall be as directed by the Technician. On completion of excavation, all borrow pits shall be left in a neat and sightly condition. All borrow areas shall be graded to blend with existing topography and sloped to prevent ponding and provide positive drainage.

WISCONSIN CONSTRUCTION SPECIFICATION

3. Earthfill

1. SCOPE

The work shall consist of placing the earthfill required by the drawings. This specification does not apply to the earthfill required for waste storage facilities.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by Technician.

Fill materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Stones larger than two-thirds of the uncompacted layer thickness shall be removed from the materials prior to compaction of the fill.

3. FOUNDATION PREPARATION

The foundation area shall be cleared of trees, stumps, roots, brush, rubbish, and stones having a maximum dimension greater than six (6) inches. Foundations shall be stripped to remove vegetation and other unsuitable materials or to the depth shown on the drawings, whichever is greater. Topsoil shall be stripped from the foundation area and stockpiled for use as a top dressing for vegetation establishment unless otherwise shown on the drawings.

Earth foundations shall be graded to remove surface irregularities and slopes steeper than 1:1.

The foundation surfaces shall be scarified parallel to the centerline of the fill to a minimum depth of 2 inches. The moisture content of the scarified materials shall be maintained as specified for the earthfill. The surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

4. PLACEMENT

Fill shall not be placed until the required excavation and preparation of the underlying foundation is completed and inspected and approved by the Technician. No fill shall be placed upon a frozen surface nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers beginning at the lowest elevation of the foundation. The thickness of each layer of fill prior to compaction shall be as specified in Table 1. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified layer thickness prior to compaction.

Adjacent to structures, earthfill shall be placed in 4-inch lifts (prior to compaction) in a manner adequate to prevent damage to the structure and to allow the structure to gradually and uniformly assume the backfill loads.

The height of the fill shall be increased at approximately the same rate on all sides of the structure.

Placement of fill adjacent to concrete structures may begin after the concrete has cured for the minimum time specified.

Earthfill in dams, levees, and other structures designed to impound water shall be placed to meet the following additional requirements:

a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

b. The embankment top shall be maintained approximately level during construction except for sectional construction as described in Section 7.

c. Dam embankments shall be constructed in continuous layers from abutment to abutment, except where openings to facilitate construction or to allow passage of stream flow during construction are specified.

d. If the surface of any layer becomes too hard and smooth to achieve a suitable bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

5. CONTROL OF MOISTURE CONTENT

Fill materials shall have a moisture content sufficient to insure the required compaction. When kneaded in the hand, the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

Fill material or the top surface of the preceding layer of compacted fill that becomes too dry to permit suitable bond shall either be removed or scarified and wetted by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

Fill material that is too wet when deposited or the top surface of the preceding layer of compacted fill that becomes too wet shall be either removed or allowed to dry to an acceptable moisture content before compaction or placing additional layers of fill.

6. COMPACTION

The Contractor shall furnish and operate the types and kinds of equipment necessary to compact the fill materials.

Unless otherwise specified on the plans or approved by the Technician, compaction requirements for each layer of fill material are as shown in Table 1.

Each pass shall consist of at least one complete coverage by the wheel, track, or roller over the entire surface of the fill layer in a direction parallel to the main axis of the fill.

Adjacent to structures or in confined areas, compaction of the fill shall be accomplished by means of manually directed power tampers or plate vibrators or hand tamping, unless otherwise specified. The Technician shall determine if adequate compaction is being achieved. Heavy equipment shall not be

operated within 2 feet of any structure. Compaction by means of drop weights operating from a crane or hoist of any type will not be permitted.

7. SPECIAL REQUIREMENTS FOR SECTIONAL CONSTRUCTION OF EMBANKMENTS

When sectional (or phase) construction of embankments is authorized, the work shall be accomplished in the following manner:

Each section of the embankment that is constructed in the first phase shall be so placed that a slope not steeper than 3 feet horizontal to 1 foot vertical is maintained at the end of the embankment section adjacent to the gap in construction or closure section.

Prior to placement of the closure sections, the surfaces of completed fills and excavations that will be in contact with the closure shall be stripped of all loose material, scarified, moistened, and recompacted as necessary.

Table 1 - Equipment Compaction Requirements

Equipment Type		Applicable Soils[1]	Maximum Fill Height[2] (feet)	Layer Thickness[3] (inches)	Minimum Passes[4]
Sheepsfoot roller (10,000 lb. min. operating weight)		ML, MH, CL, CH or SM, SC, GM, GC with >20% fines	None	9	1
Vibratory tamping roller (9,000 lb. min. operating weight)		SM, SC, GM, GC	None	9	2
Rubber-tired scraper (fully loaded)		GM, GC, SM, SC, ML, MH, CL, CH	20	9	1
Rubber-tired front end loader (fully loaded)		GM, GC, SM, SC, ML, MH, CL, CH	20	6	1
Track-type crawler (standard tracks)	30,000 lb. min.	GM, GC, SM, SC, ML, CL	10**	6	2
		SP, SW, GP, GW	6**	12	4
		CL, ML, SC, SM	15##	3	2
	less than 30,000 lb.	GM, GC, GP, GW, SM, SC, SP, SW, ML, CL	6**	6	2
Farm tractor (2,400 lb. min.)		GM, GC, SM, SC, ML, MH, CL, CH	15	6	2
Steel drum vibratory roller (10,000 lb. min.)		SP, SW, GP, GW	None**	12	2

[1] Unified Soil Classification System.

[2] Measured from the top of the fill to the lowest point along the centerline of the fill.

[3] Prior to Compaction.

[4] The Technician shall determine if adequate compaction is being achieved. Additional passes may be required.

** The fill shall not have a permanent body of water stored against it.

This method may only be used for embankments that will not have the potential for a permanent body of water stored against it that is greater than 1/4 acre in surface area or more than 6 feet deep.

WISCONSIN CONSTRUCTION SPECIFICATION

4. CONCRETE

1. SCOPE

The work shall consist of furnishing, forming, placing, consolidating, finishing, and curing Portland cement concrete and the furnishing and placing of steel reinforcement or other appurtenances as required on the construction drawings. All materials, test procedures, and admixtures shall meet the requirements of the latest edition of the applicable ASTM designation.

Failure to meet any requirements contained in this specification may be cause for rejection of the concrete or delay of placement.

2. DEFINITIONS

The following definitions are provided for the purpose of this specification. The words that are defined in this section are italicized the first time that they are used in the text.

Batch delivery ticket refers to the form showing the total weights of all the ingredients used to mix the contents of the rotating drum mixer (total weights of all ingredients on the load) and other job-pertinent information.

Consolidating refers to the process of reducing the volume of entrapped air in a fresh cementitious mixture, usually accomplished by inputting mechanical energy.

Construction joints are those joints where two successive placements of concrete meet through, which reinforcement is continuous and bond is required between the two pours.

Finishing refers to the process of treating surfaces of fresh or recently placed concrete or mortar to produce desired appearance and service.

Firm refers to the condition of the subgrade where it is not significantly displaced or deformed by foot traffic during construction, and is able to properly support reinforcement chairs.

Flatwork refers to concrete slabs poured on slopes flatter than 5:1 (Horizontal:Vertical).

Formed surfaces are those that require a temporary structure or mold for the support of concrete while it is setting and gaining sufficient strength to be self-supporting, such as walls or poured-in-place tank lids.

Hand tamping refers to the operation of consolidating freshly placed concrete by hand-held implements.

Honeycomb refers to voids left in concrete due to failure of the mortar to effectively fill the spaces among coarse aggregate particles.

Jitterbug refers to a grate tamper for pushing coarse aggregate slightly below the surface of a slab to facilitate finishing.

Liquid-tight concrete refers to applications using specific placement and finishing techniques, and design features to minimize the loss of liquids.

Manufacturer refers to the producer/supplier of the ready-mixed concrete.

Mesh roller refers to a finishing tool consisting of a rolling drum attached to a handle, of which the surface of the drum is made of mesh, sometimes used for rolling over the surface of fresh concrete to embed coarse aggregate

Rock pocket refers to a porous, mortar-deficient portion of hardened concrete consisting primarily of coarse aggregate and open voids; caused by leakage of mortar from the form, separation (segregation) during placement, or insufficient consolidation.

Sloped slabs refers to concrete slabs poured on slopes of 5:1 (Horizontal:Vertical) or steeper.

Technician refers to an individual trained in specific technical processes, and may include an engineer, government agency representative, private sector technical service provider, qualified independent third party quality assurance inspector, or a similar person that is primarily responsible for the project quality assurance.

Ternary mix is a mixture using three cementitious materials, such as Portland cement, fly ash, and ground granulated blast-furnace slag (slag).

Top bars are horizontal reinforcements placed such that more than 12 inches of fresh concrete is cast below the reinforcing bar (such as horizontal wall bars).

Vibration refers to mechanical energetic agitation of freshly mixed concrete during placement by mechanical devices, either pneumatic or electric, that create vibratory impulses of moderately high frequency to assist in consolidating the concrete.

- Internal vibration employs one or more vibrating elements that can be inserted into the fresh concrete at selected locations.
- Surface vibration employs a portable horizontal platform on which a vibrating element is mounted.

Water-cement ratio (w/c) is the ratio of the weight of free water (excluding that absorbed by the aggregates) to the weight of Portland cement in a concrete mix expressed as a decimal.

Water-cementitious material ratio (w/cm) is the ratio of the weight of free water (excluding that absorbed by the aggregates) to the weight of cementitious material (fly ash, Portland cement, and slag) in a concrete mix expressed as a decimal.

3. MATERIALS

The Contractor shall provide test data, independent laboratory reports, or other evidence from the concrete manufacturer showing that all materials meet the requirements of this specification. All materials proposed for use shall be approved by the Technician.

1. Portland cement shall conform to ASTM C 150 and shall be Type I, II, or III.

2. Fine aggregate shall conform to ASTM C 33 and be composed of clean, uncoated grains of material. Refer to the fine aggregate gradation table in Section 4 of this specification.

3. Coarse aggregates shall be gravel or crushed stone conforming to ASTM C 33 and be clean, hard, durable, and free from clay or coating of any character. Refer to the coarse aggregate gradation table in Section 4 of this specification.

4. Water shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances.

5. Air entraining agent shall conform to ASTM C 260.

6. Pozzolan (fly ash) shall conform to ASTM C 618, Class C or F. The loss of ignition shall not exceed 2 percent for Class C and 6 percent for Class F.

7. Ground granulated blast furnace (GGBF) slag shall conform to ASTM C 989.

8. Chemical admixtures shall be used in strict compliance with the manufacturer's recommendations, conform to ASTM C 494, and may be the following types:

    1. Type A - Water-reducing admixtures.
    2. Type B - Retarding admixtures.
    3. Type C - Accelerating admixtures.
    4. Type D - Water-reducing and retarding admixtures.
    5. Type E – Water-reducing and accelerating admixtures.
    6. Type F - Water-reducing, high range admixtures (superplasticizers).
    7. Type G - Water-reducing, high range, and retarding admixtures (superplasticizers).

    If Type C or E is used, the manufacturer shall provide the Technician a product data sheet verifying that the product is a non-chloride accelerator.

    Calcium chloride or admixtures containing chloride ions other than from impurities in admixture ingredients shall not be used.

9. Preformed expansion joint filler shall be commercially available products made of sponge rubber, closed cell foam, or boards containing bituminous materials. The joint filler shall have a minimum thickness of ½ inch and a width equal to the full cross sectional width of the concrete at the joint.

10. Deformed reinforcing bars shall be free from loose rust, oil, grease, paint, or other deleterious matter. Steel bars for concrete reinforcement shall meet the requirements of ASTM A 615. The steel shall be deformed Grade 40 or Grade 60 billet-steel bars as noted on the plans.

11. Deformed welded wire reinforcement (WWR) shall conform to the requirements of ASTM A 1064 and shall be furnished in flat sheets, and shall be size D4 or larger as indicated on the plans. This material may only be used for non-structural elements such as slabs on grade. Spacing of welded intersections shall not exceed 16 inches.

12. Embedded waterstops shall be made of polyvinyl chloride (PVC) having a minimum width of 6 inches, or the width and material shown on an NRCS approved Wisconsin Standard Drawing. The waterstop web thickness shall be a minimum of 3/16 inches throughout the entire cross section of the waterstop. Waterstops shall be the type intended for placement entirely within the concrete cross section, or as shown on an NRCS approved Wisconsin Standard Drawing or other drawings as approved by the NRCS State Conservation Engineer. Waterstops shall have ribbed or "dumb-bell" type anchor flanges and a hollow tubular center bulb. Split flange waterstops are prohibited.

13. Curing compound shall be a liquid membrane-forming compound suitable for spraying on the concrete surface. The curing compound shall meet the requirements of ASTM C 309, Type 2 (white pigmented).

14. Expansive waterstops shall consist of preformed strips or mastic (caulk) made of hydrophilic materials that expand when subjected to moisture and shall not contain bentonite. Use shall be limited to non-movement joints (fixed joints).

4. Design of the Concrete Mix

The Contractor is responsible for submitting documentation of the proposed design mix to the Technician at least seven (7) days prior to the start of concrete placement. The Contractor is responsible for providing a mix that will meet the minimum compressive strength, *water-cement/water-cementitious ratio*, and mix requirements stated in the construction plans.

The minimum 28-day compressive strength shall be 3,500 psi unless otherwise specified in the construction plans. The water-cement (w/c) or the water-cementitious material (w/cm) ratio shall not exceed 0.45 for all concrete construction. The minimum cementitious material required shall be 564 pounds (± 1 percent) per cubic yard of concrete. The cementitious material may include a maximum of 25 percent (by weight) of fly ash or a maximum of 30 percent (by weight) of ground granulated blast-furnace (GGBF) slag. Mixes containing both fly ash and GGBF slag shall not exceed 30 percent in combination (*ternary mix*) and no more than 25 percent shall be fly ash. The remaining cementitious materials shall be Portland cement.

The air content (by volume) shall be 6 ± 1.5 percent of the volume of the concrete at the time of placement.

The maximum allowable slump, without the use of superplasticizers, shall be 5 inches (± 1½ inches). When superplasticizers are used, the slump shall not exceed 8 inches. Water-reducing admixtures may be used to increase the workability of concrete up to the maximum allowable slump while not exceeding the 0.45 water-cement (w/c) ratio or water-cementitious material (w/cm) ratio. Additional superplasticizer shall not be added to the concrete mix after discharge of the concrete at the job site has commenced.

The fine aggregate oven dry weight shall be 30-45 percent of the total oven dry weight of the combined coarse and fine aggregates. The well-graded fine aggregate shall conform to the following ASTM C 33 or Wisconsin DOT gradation requirements shown below:

Fine Aggregate Gradation

Sieve Size	Percent Passing By Weight	
	ASTM C 33	WI DOT
⅜" (9.5 mm)	100	100
No. 4 (4.75 mm)	95-100	90-100
No. 8 (2.36 mm)	80-100	---
No. 16 (1.18 mm)	50-85	45-85
No. 30 (600 µm)	25-60	---
No. 50 (300 µm)	5-30	5-30
No. 100 (150 µm)	0-10	0-10

The well graded coarse aggregate shall conform to the following ASTM C 33 gradation requirements for size number 67 aggregate shown below:

Coarse Aggregate Gradation

Sieve Size	Percent Passing By Weight
1" (25.0 mm)	100
¾" (19.0 mm)	90-100
⅜" (9.5 mm)	20-55
No. 4 (4.75 mm)	0-10
No. 8 (2.36 mm)	0-5

5. MIXING

Ready-mixed concrete shall be in accordance with ASTM C 94 for ordering (option C), batching, mixing, and transporting.

Concrete shall be uniform and thoroughly mixed when delivered to the forms.

No mixing water in excess of the amount shown for the design mix submitted by the Contractor shall be added to the concrete during mixing, hauling or after arrival at the delivery point.

The concrete shall be batched and mixed such that the temperature of the concrete at time of placement shall not be less than 55 degrees Fahrenheit or, at no time during its production or transportation more than 90 degrees Fahrenheit.

6. BATCH DELIVERY TICKET INFORMATION

The Contractor shall obtain from the manufacturer a batch delivery ticket for each load of concrete before unloading at the site. Any concrete load delivered without a batch delivery ticket containing all the following information shall not be allowed to be discharged in any part of the construction project covered under this specification.

The following minimum information shall be included on the batch delivery ticket.

1. Job-pertinent information

   - Name of concrete manufacturer and batch plant
   - Name of purchaser and job location
   - Date of delivery
   - Truck number
   - Amount of concrete delivered
   - Time loaded or time of first mixing of cement and aggregates

2. Ingredients used to mix the batch

   - Mixing water in the load added as free water
   - Percent moisture content, or weight of free water contained in the aggregates
   - Percent moisture content, or weight of free water absorbed by the aggregates

- Type and amount of cementious materials
- Type and amount of admixtures
- Weights of fine and coarse aggregates

3. The Contractor is responsible for adding the following information

- Volume of water added by the receiver of the concrete
- Time the concrete arrived at the site
- Time the concrete was completely unloaded

Upon completion of the concrete placement, copies of all batch delivery tickets shall be provided to the Technician.

7. INSPECTION AND TESTING

The inspection and testing details of this section shall apply when specific concrete tests are required in the construction drawings or quality assurance plan. This testing does not relieve the Contractor of the responsibility to perform the work according to this specification. The Technician shall have free access to the work site to obtain samples.

When testing is conducted, the following methods shall be used:

Type of Test	Test Method (ASTM Designation)
Sampling	C 172
Slump	C 143
Air Content	C 231 or C 173
Making and Curing Specimens in the Field	C 31
Obtaining and Testing Drilled Cores	C 42
Compressive Strength	C 39
Density (Unit Weight)	C 138
Temperature	C 1064

Compressive strength of the concrete shall be considered satisfactory if test results equal or exceed the 28-day design strength. For each ASTM C 39 strength test, three test specimens shall be made. The test result shall be the average of the compressive strength tests of any two of the three test specimens. If one test specimen shows evidence of improper sampling, molding, or testing, it shall be discarded and the remaining specimens tested. The strengths of the remaining two specimens shall be averaged, and the result shall then be considered the compressive strength of the concrete. If more than one specimen shows such defects, the test is not valid and the remaining specimen shall be discarded.

If test results are invalid due to specimen defects, or the in-place concrete that is in question was not sampled, the in-place concrete may be sampled by coring in accordance with ASTM C 42. For core tests, at least three representative cores shall be taken from each area of the concrete in question. If one or more of the cores shows signs of being damaged before testing, it shall be replaced by a new one.

8. PLACEMENT OF SUBGRADE, FORMS, REINFORCING STEEL, AND WATERSTOP

A. Subgrade

The site shall be graded to the dimensions and elevations as specified in the construction plans.

All surfaces shall be firm and damp prior to placing concrete. Concrete shall not be placed on mud, dried earth, uncompacted fill, frozen subgrade, or in standing water. The use of plastic sheeting to isolate the concrete from unsuitable foundations shall not be permitted.

B. Forms

The forms and associated bracing shall be substantial, unyielding and constructed so that the finished concrete will conform to the specified dimensions and contours. Forms shall be mortar tight. Forms shall be coated with a form release agent before being set into place. Form release agent shall not come in contact with the steel reinforcement, waterstop, or with hardened concrete against which fresh concrete is to be placed.

For structures which are to be liquid-tight, form ties shall be used that permit their removal to a depth of at least ½ inch.

Concrete joints shall be placed at locations and be of the type shown on the construction drawings.

C. Reinforcing Steel

Reinforcement shall be accurately placed as shown on the drawings and secured in position in a manner that will prevent its displacement during the placement of concrete.

1. Tolerances - The following tolerances will be allowed in the placement of reinforcement:
   - Where 1½ inches clear distance is shown between reinforcing steel and forms, or embedded objects, allowable clear distance is 1⅛ to 1½ inches.
   - Where 2 inches clear distance is shown between reinforcing steel and forms, allowable clear distance is 1⅝ to 2 inches.
   - Where 3 inches clear distance is shown between reinforcing steel and earth or forms, allowable clear distance is 2½ to 3 inches. Over-excavation backfilled with concrete shall not be considered as clear distance.
   - The maximum variation from the reinforcing steel spacing shown, shall be 1/12 of the spacing, without a reduction in the amount of reinforcing steel specified.
   - The ends of all reinforcing steel shall be covered with at least 1½ inches of concrete, with an allowable minimum distance of 1⅛ inches.
2. Reinforcement Support - Holding steel reinforcement in position with temporary supports is not permitted. Tack welding of bars is not permitted. Metal chairs, metal hangers, metal spacers, plastic chairs, or concrete chairs shall be used to support the reinforcement. Precast concrete chairs shall be manufactured from concrete equal in compressive strength to the concrete being placed. Reinforcement shall be supported at a minimum as follows:
   a. Deformed reinforcing bars for flatwork and sloped slabs shall be supported by a minimum of 1 support chair every 4 feet in each direction. Reinforcement shall not deflect or sag between supports. Deformed reinforcing bars shall be tied at every other rebar intersection or as approved by the Technician.

b. Deformed welded wire reinforcement (WWR) shall be supported no further than as indicated in the table below.

WWR Support

Welded Wire Reinforcement Size[(1)]	Welded Wire Spacing	Maximum Support Spacing in Each Direction[(2)], feet
D9 or larger	12 inches or more	4 to 6 feet
D5 to D8	12 inches or more	3 to 4 feet
D9 or larger	Less than 12 inches	3 to 4 feet
D4 to D8	Less than 12 inches	2 to 3 feet

Notes: (1) "D" is the standard designation for deformed wire.
(2) Support spacing shall be adequate to support all loads, including construction personnel and equipment. If excessive deflections occur, closer support spacing is required.

Flatwork reinforcement may be driven on prior to placement of supports if both of the following conditions are met:

- The subgrade is firm so that minimal displacement is made by equipment. If significant displacement occurs, the steel shall be removed, the subgrade regraded and compacted before steel and concrete placement.
- The reinforcing steel is not deformed by the equipment. If the steel is deformed, it shall be replaced before concrete placement.

Steel tying to protruding steel from a previous pour or form construction for new concrete that will be in contact with previously poured concrete shall not be started until the previously poured concrete has cured a minimum of 12 hours.

3. Reinforcement Splice Lengths and Bend diameters:

a. Deformed reinforcing bars

Bend diameter: 6 bar diameters for #3 through #8 bar sizes and 8 bar diameters for larger bars. Reinforcing bars shall not be heated to facilitate bending.

Splice Length: The minimum splice lengths in the table below are for 3,500 psi concrete (28-day design compressive strength). Other concrete strengths and reinforcement grades require different splice lengths in accordance with ACI 318. Deformed reinforcing bars shall not be spliced by welding. All lap splices shall be adequately tied together to firmly hold the reinforcement in position to maintain the proper splice length.

Minimum Splice Lengths [Note 1]

	Grade 40	Grade 60
#3 through #6 bars		
Top bars	27 bar diameters	41 bar diameters
all other bars	21 bar diameters	32 bar diameters
#7 and larger bars		
Top bars	34 bar diameters	51 bar diameters
all other bars	26 bar diameters	40 bar diameters

Note 1: Splice lengths shall be the greater of that indicated in the Table or 12-inches.

b. Deformed welded wire reinforcement (WWR) - Splice length shall be in accordance with the requirements of ACI 318-08 or ACI 318-11 Part 12.18. Deformed welded wire reinforcement shall not be spliced by welding. All lap splices shall be tied to firmly hold the reinforcement in position to maintain the proper splice length.

D. Embedded Waterstop

Embedded waterstops shall be located as shown on the drawings and secured in position so that displacement does not occur during concrete placement. Vertical applications (footing to wall joints and wall to wall joints) shall be secured to reinforcement using wire or "hog ring" type fasteners or factory installed grommets at the outermost rib at the spacing as recommended by the waterstop manufacturer (usually 12 inches on center). Hog rings shall be factory installed, if the manufacturer has that option available. Each waterstop shall be placed and secured with the hollow bulb aligned in the center of the planned joint.

Waterstop clearance shall be a minimum of 1½ inches from reinforcement and one half the waterstops width to the face of the concrete (3 inches for 6 inch wide waterstop).

Manufacturers' fabricated waterstop intersections shall be provided. Only straight butt joint splices are allowed for field fabrication. Splices in waterstops shall be welded as recommended by the manufacturer. Manufacturer-certified contractors may fabricate waterstop intersections in a controlled environment and with proper manufacturers' equipment. Prior to the time of delivery of the fabricated intersections, documentation of certification must be presented to the Technician.

Joints with embedded waterstops shall not be placed horizontally across sloped slabs.

Continuous placement of concrete through a waterstop joint is not allowed, except for control joints in formed walls where preformed joint control formers are used in conjunction with the waterstops, or in control joints as shown on an NRCS approved Wisconsin Standard Drawing or other drawings as approved by the NRCS State Conservation Engineer.

E. Expansive Waterstop

Expansive waterstop shall be placed at the locations shown on the drawings in accordance with the manufacturer's instructions. Preformed strips may require adhesive or other forms of mechanical fastening to existing concrete based on the manufacturer's instructions. Mastic (caulk) type expansive waterstops shall be placed to the bead size as recommended by the manufacturer based on the amount of concrete cover provided. The adhesive for preformed expansive waterstop and the mastic for caulk type expansive waterstop shall be allowed to cure for the duration as indicated by the manufacturer prior to placing concrete over the waterstop. Colder temperatures will require longer curing periods prior to concrete placement. Do not allow the expansive waterstop to become wet prior to placing concrete over the waterstop.

9. PLACING, CONSOLIDATING, AND FINISHING CONCRETE

The Contractor shall notify the Technician of the proposed method of placement, consolidation, and finishing of the concrete at least seven (7) days prior to the start of concrete placement.

A. General

Prior to placement of concrete, the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Concrete shall not be placed until the subgrade, forms, waterstop, and steel reinforcement have been inspected and accepted by the Technician. Any deficiencies shall be corrected before the concrete is delivered for placement. Forms, reinforcing steel, and subgrade shall be moistened prior to placing concrete.

B. Delivery

Concrete shall be delivered to the site and discharged into the forms within 1½ hours after the introduction of the mixing water to the cement and aggregates, or when a superplasticizer is used, the manufacturer's recommended time limit for discharge after addition shall apply. The 1½ hour time may be extended if the concrete is of a slump that it can be placed, consolidated, and finished without the addition of water to the batch. Upon arrival at the job site, addition of water will be allowed to adjust the slump, provided such addition does not exceed the water-cement (w/c) ratio or water-cementitious material ratio (w/cm) specified in the approved design mix. A small amount of concrete may be discharged prior to the addition of water. Final placement of the batch shall begin immediately after mixing of the added water is completed. No additional water shall be added to the mix after placement has begun.

C. Placement

Concrete shall be deposited as closely as possible to its final position. Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates. All placement shall be done in a manner that prevents incorporation of subgrade material into the concrete.

Methods for placing concrete on sloped slabs shall only include chutes, pumps, conveyors, wheelbarrows, or similar means of directly depositing concrete as near as possible to its final position. Placement of concrete by other methods where concrete is deposited upslope and flows to its final position downslope (commonly called “lava flow”, “glacial pours”, etc.) shall not be permitted.

Concrete shall not be dropped more than 6 feet vertically unless suitable equipment is used to prevent segregation. Concrete containing superplasticizer shall not be dropped more than 12 feet vertically and shall not be placed in lifts exceeding 6 feet in depth. Non-superplasticized concrete shall be placed in forms in horizontal layers not more than 24 inches deep. Each layer shall be thoroughly consolidated before the next is placed, at a rate such that previously placed concrete has not yet set when the next layer of concrete is placed upon it.

D. Consolidation

1. Formed Surfaces

Immediately after the concrete is placed in the forms, it shall be consolidated by internal vibration or hand tamping as necessary to insure dense concrete. Concrete in walls 4 feet and higher shall be vibrated. Concrete supplied with superplasticizer shall be placed with a minimum amount of vibrating and finishing effort. Vibration shall not be applied directly to the reinforcement steel or the forms, nor to concrete that has hardened to the degree that it does not become plastic when vibrated. Each pour shall be consolidated to insure a

monolithic bond with the preceding pour. The use of vibrators to transport concrete in the forms, slabs or conveying equipment will not be permitted.

2. Slabs

Immediately after the concrete is placed, it shall be consolidated by hand or mechanical methods as necessary to insure dense concrete.

- Surface vibrators may be used to consolidate slabs 8 inches and less in thickness.
- Slabs more than 8 inches thick shall be consolidated with internal vibration and may be augmented through use of a surface vibrator.

Surface vibrators include vibrating screeds, plate or grid vibratory tampers, or vibratory roller screeds. (Mesh rollers, jitterbugs, and grate tampers are finishing tools and not consolidation tools.)

3. Embedded Waterstops

Internal vibration is required along the entire length of all joints that contain embedded waterstops for both formed surfaces and slabs.

E. Finishing

All screed support devices shall be removed from the concrete or driven down flush with the subgrade prior to finishing.

1. Formed Surfaces: All formed concrete surfaces shall be true and even, and shall be free of depressions, holes, projections, bulges, or other defects in the specified surface finish or alignment. All surface defects shall be repaired as stated in the "Form Removal" section of this specification.

2. Slabs: All flatwork and sloped slabs shall be worked to a uniform grade, maintaining the specified thickness. Concrete shall be worked to minimize segregation and in a manner that does not adversely affect the structural integrity, durability or function of the structure. Surfaces shall be free from rock pockets, or honeycomb areas or other harmful irregularities or defects.

   Water shall not be sprinkled or added to the surface of the concrete to facilitate finishing. An additional finish shall be applied if specified in the construction plans.

   The proposed finished texture (broom, float, mesh roller, trowel, non-slip, etc.) of the concrete surface shall be approved by the Technician.

   Evaporation reducer may be used during the finishing operation if approved by the Technician. Curing of the concrete is still required as per Section 11, Curing.

   If a protective concrete coating is specified on the drawings, the coating manufacturer's recommendations for curing and surface preparation shall be followed.

F. Construction Joints

If the concrete sets during placement to the degree that it will not flow and merge with the succeeding pour when tamped or vibrated, the Contractor shall discontinue placing concrete and install a formed construction joint. The Contractor shall be prepared to install unplanned

construction joints in the event that there is an interruption of the pour, equipment breakdown, or other problem which makes it necessary to stop placement of concrete at locations other than those previously planned. The reinforcement shall pass through the joint, unless otherwise indicated on the construction plan. Prior to the succeeding pour, the joint surface shall be cleaned to remove all unsatisfactory concrete, laitance, coatings, stains, or debris by one of the following methods:

1. The joint surface shall be cleaned to expose the fine aggregate and sound surface mortar, but not so deep as to undercut the edges of coarse aggregate. Cleaning shall be by wire brush, sandblasting, or high pressure air-water cutting after the concrete has gained sufficient strength to prevent displacement of the coarse aggregate. The joint surface shall be washed to remove all loose material after cutting.

2. According to methods specified by the person approving the construction plans.

   The surfaces of all construction joints shall be wetted and standing water removed immediately prior to placement of the new concrete. The new concrete shall be placed directly on the cleaned and washed surface. New concrete shall not be placed until the hardened concrete has cured at least 12 hours. The newly placed concrete shall be consolidated to achieve a good bond with the previously hardened concrete.

10. Form Removal and Concrete Repair

A. Form Removal

Forms shall be removed without damage to the concrete. Supports shall be removed in a manner that permits the concrete to take the stresses due to its own weight uniformly and gradually. The minimum period from completion of the concrete placement to the removal of the forms shall be based on either strength tests or cumulative times.

1. Strength Tests: The strength of the in-place concrete is determined by testing concrete cylinders specifically cast for this purpose and cured adjacent to the member in accordance with the ASTM C 31 methods for determining removal time. Unless otherwise specified, forms supporting the weight of the concrete member may be removed after the concrete strength is 70 percent of that specified for the 28-day compressive strength.

2. Cumulative Time: The total accumulated time, not necessarily continuous, that the air adjacent to the concrete is above 50 degrees Fahrenheit will be determined by the Contractor/Technician. The forms may be removed after the total accumulated time shown in the following table:

Form Removal

Forms		Time
Sides of slabs or beams without waterstop		12 hours
Sides of slabs or beams with waterstop		24 hours
Undersides of slabs or beams	Clear Span < 10 feet	4 days
	10-20 feet	7 days
	>20 feet	14 days
Sides of walls or columns	Height of forms < 20 feet	24 hours
	>20 feet	72 hours

For structures which are not required to be liquid-tight, form ties shall be removed flush with or below the concrete surface. For structures which are to be liquid-tight, form ties shall be removed to a minimum depth of ½ inch. All cavities or depressions resulting from form tie removal shall be patched in accordance with Part C of this Section.

Forms shall be removed and the concrete inspected by the Technician before walls are backfilled. Concrete loading shall be in accordance with Section 14, Loading New Reinforced Concrete Structures.

B. Repair of Surface Defects (other than tie holes)

Immediately after removal of the forms, concrete which is honeycombed, damaged or otherwise defective as identified by the Technician shall be repaired or replaced by the Contractor. All repairs of surface defects shall be completed prior to the application of curing compound. Repair of surface defects such as honeycombed or otherwise defective concrete shall be made using bonding grout and site mixed Portland cement mortar or other products specifically intended to repair surface defects that are applied in accordance with the manufacturer's recommendations.

1. Bonding grout and site mixed Portland cement mortar:

   a. Outline the honeycombed or otherwise defective concrete with a ½ to ¾ inch deep saw cut and remove such concrete down to sound concrete. When chipping is necessary, leave chipped edges perpendicular to the surface or slightly undercut. Do not feather edges.

   b. Dampen the area to be patched plus another 6 inches around the patch area perimeter.

   c. Prepare bonding grout by mixing approximately one part Portland cement and one part fine sand with water to the consistency of thick cream.

   d. Thoroughly brush the bonding grout into the surface. When the bond coat begins to lose water sheen, apply repair mortar. Repair mortar is made by mixing 1 part Portland cement to 2½ parts fine sand (approximately finer than the No. 16 sieve size) by damp loose volume. The mortar shall be at a stiff consistency with no more mixing water than is necessary for handling and placing. Mix the repair mortar and manipulate the mortar frequently with a trowel without adding water.

   e. Thoroughly consolidate the mortar into place and strike off, leaving the patch slightly higher than the surrounding surface to compensate for shrinkage. Leave the patch undisturbed for 1 hour before finishing. The repair shall be cured as specified Section 11, Curing.

2. Repair materials other than site mixed Portland cement:

   a. Portland cement mortar modified with a latex bonding agent conforming to ASTM C 1059, Type II.

   b. Epoxy mortars and epoxy compounds that are moisture-insensitive during application and after curing and that embody an epoxy binder conforming to ASTM C 881, Type III. The type, grade, and class shall be appropriate for the application as specified in ASTM C 881.

   c. Nonshrink Portland cement grout conforming to ASTM C 1107.

d. Packaged dry concrete repair materials conforming to ASTM C 928.

e. Other products specifically intended to repair surface defects that are applied and cured in accordance with the manufacturer's recommendations.

C. Repair of Form Tie Holes

Liquid-Tight Concrete Structures – Repair tie holes immediately after formwork removal and prior to the application of curing compound. All cavities or depressions resulting from form tie removal shall be patched with commercially available patching products or site mixed Portland cement repair mortar.

1. Site-mixed Portland cement repair mortar

Repair mortar is made by mixing 1-part cement to 2.5-parts fine sand (approximately finer than the No. 16 sieve size) by damp loose volume. Mortar shall be at a stiff consistency with no more mixing water than is necessary for handling and placing. Mix the repair mortar and manipulate the mortar frequently with a trowel without adding water. Clean and dampen tie holes before applying the mortar. Cure in accordance with Section 11, Curing.

2. Repair materials other than site mixed Portland cement:

a. All those materials listed in Section 10.B.2.a-d.

b. Other products specifically intended to fill form tie holes for liquid-tight applications that are applied and cured in accordance with the manufacturer's recommendations.

11. CURING

Concrete shall be cured for a period of at least 7 consecutive days (curing period) after it is placed, except as stated in Section 13. Exposed concrete surfaces shall be kept continually wet during the entire curing period or until curing compound is applied.

Curing compound shall be applied at the rate and with the proper equipment recommended by the manufacturer. It shall form a uniform, continuous, adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections.

Curing compound shall not be used at construction joints or other areas that are to be bonded to additional concrete. Surfaces subjected to heavy rainfall or running water within 3 hours after the application of curing compound, or surfaces damaged by subsequent construction operations during the curing period, shall be recoated in the same manner as the original application.

12. CONCRETING IN HOT WEATHER

For the purpose of this specification, hot weather is defined as any combination of the following conditions that impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise resulting in detrimental results:

- High ambient temperature (generally above 80 degrees Fahrenheit)
- High concrete temperature
- Low relative humidity
- Wind velocity
- Solar radiation

In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the mixing water to the cement and aggregates and discharge shall not exceed 45 minutes unless a set-retarding admixture is used meeting the requirements in Section 3 of this specification. The 45 minute time may be extended if the concrete is of a slump that it can be placed, consolidated, and finished without the addition of water to the batch.

Special provisions shall be made to immediately protect and cure the concrete due to rapid drying conditions. Concrete surfaces shall not be allowed to dry after placement and during the curing period. It may be necessary to:

- Restrict placement to early morning, late afternoon or evening.
- Restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration.
- Use a fog spray to raise the relative humidity of the ambient air.
- Moist cure the concrete surface as soon as the surfaces are finished and continue for at least 24 hours.
- Schedule mixer trucks to avoid waiting time so the concrete will not begin to set.
- Suspend placement until conditions improve.

13. CONCRETING IN COLD WEATHER

The following provisions shall apply when the minimum air temperature at the local job site is less than 35 degrees Fahrenheit (forecast temperature and verified with a maximum/minimum thermometer at the start of the morning job shift).

A. No concrete shall be placed without the required thermometers at the job site.

B. The Contractor shall furnish the Technician a record of daily temperature data including:

   - Outside air maximum and minimum temperatures at the local job site, and
   - Temperatures, of the air adjacent to the surface of the concrete, at several points along the concrete surface for all concrete curing periods.

C. When the cement is initially added to the mix, the temperature of the mixing water shall not exceed 100 degrees Fahrenheit nor shall the temperature of the aggregate exceed 100 degrees Fahrenheit.

D. The temperature of the concrete at the time of placement shall be not less than 55 degrees Fahrenheit or at no time during its production or transport more than 80 degrees Fahrenheit.

E. At no time, during the first 10 days after concrete is placed, shall the minimum air temperature adjacent to the surface of the concrete be less than 32 degrees Fahrenheit.

F. The minimum air temperature adjacent to the surface of the concrete shall be maintained above 40 degrees Fahrenheit for a period of at least 7 accumulated days. These 7 days must occur during the first 10 days after the concrete is placed.

G. Placed concrete may be protected by covering, housing, insulating or heating concrete structures.

H. Combustion heaters shall have exhaust flue gases vented out of the concrete protection enclosure. The heat from heaters and ducts shall be directed in such a manner as to not overheat or dry the concrete in localized areas or to dry the exposed concrete surface.

I. The curing period may be reduced from 7 cumulative days to 3 consecutive days when Type III cement or an approved accelerating admixture is used.

At the end of the curing period, the concrete shall be allowed to cool gradually. The maximum temperature decrease at the concrete surface in a 24-hour period shall not exceed 40 degrees.

14. Loading New Reinforced Concrete Structures

Backfill material shall be the type indicated on the drawings and shall be free of large stones or debris.

Compaction within 3 feet of the new structure wall will be by means of small manually directed tamping or vibrating equipment.

The age of concrete shall be at least 7 days before any load (including backfill) is applied other than the weight of the wall, forms, or scaffolds for succeeding lifts or light equipment. The 7-days may be reduced to 3 days when Type III cement or an approved accelerating admixture is used. Loads may also be applied to new concrete less than 7 days after placement when 75 percent of the design strength has been attained through compressive strength testing on cylinders that have been cured on-site under field conditions.

WISCONSIN CONSTRUCTION SPECIFICATION

5. Construction Site Pollution Control

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air from construction activities.

2. MEASURES

Erosion and sediment control measures and works shall be installed to prevent or minimize sediment production and transport offsite. The measures and works shall include, but are not limited to, the following:

a. Diversions - Divert water from work areas and collect water from work areas for treatment and safe disposition. Temporary diversions shall be removed and the area restored to its near original condition when the diversions are no longer required or when permanent measures are installed.

b. In-Channel Sediment Control - Sediment produced within the stream channel during construction will be retained in the work area. Sediment retention will be accomplished by using a temporary, excavated sediment trap and/or a barrier constructed of geotextile and hay bales. Turbid water in the retention area may be pumped to a well-vegetated area away from the stream. The vegetation will serve to filter the sediments before the flow returns to the stream. Discharge areas from all pump hoses shall be stabilized. At no time shall the pump discharge be allowed to cause erosion at the discharge point.

c. Mulching - Mulch provides temporary protection of the soil surface from erosion. The method of application is specified on the construction drawings

d. Sediment Basins - Sediment basins collect, settle, and eliminate sediment from eroding areas from impacting properties and streams below the construction site(s). These basins are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

e. Sediment Filters - Straw bale filters or geotextile sediment fences (silt fence) trap sediment from areas of limited runoff. Sediment filters shall be properly anchored to prevent erosion under or around them. These filters are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed. The method is shown on the construction drawings.

f. Seeding - Seeding to protect disturbed areas shall occur as soon as reasonably possible following completion of that earthwork activity. All seeding operations shall be performed in such a manner that the seeds are applied in the specified quantities uniformly in the designated areas. The method and rate of seed application are specified on the construction drawings

g. Silt Curtain or Turbidity Barrier - Silt Curtain and Turbidity Barriers can be used to minimize the transport of sediment from an area where construction activities are occurring within or directly adjacent to a waterway or waterbody. The fabric shall be removed after the construction activities have ceased and the sediment has settled. Care should be taken to prevent the re-suspension of sediment during removal.

h. Staging of Earthwork Activities - The excavation and moving of soil materials shall be staged to minimize the area disturbed and the time these locations are vulnerable to erosion.

i. Stockpiling Material - The stockpiled materials shall be protected from concentrated flows and/or flooding, to minimize sediment movement offsite.

j. Stream Crossings - Culverts or bridges should be used where equipment crosses streams. They are temporary and shall be removed and the area restored to its near original condition when the crossings are no longer required or when permanent measures are installed.

k. Waterways - Waterways shall be used to safely dispose of runoff from fields, diversions, and other structures or measures. These works are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

l. It is the responsibility of the contractor or their designee for the cleanup or removal of sediment transported offsite due to failure to maintain erosion control measures during all phases of the construction.

3. CHEMICAL POLLUTION

The contractor shall safely dispose of chemical pollutants (such as drained lubricating or transmission fluids, grease, soaps, concrete mixer washwater, or asphalt, produced as a byproduct of the construction activities) off site. The contractor is responsible for reporting and clean up of all accidental spills and leaks.

In the event a piece of equipment develops a leak during the construction work, the leak shall be repaired before work continues. All excess fluids will be cleaned from the machine prior to its return to the work area.

If a leak occurs when equipment is working in or near a waterbody, the machine shall be immediately moved a safe distance away from the waterbody.

4. AIR POLLUTION

The burning of brush or slash and the disposal of other materials shall adhere to state and local regulations.

Fire prevention measures shall be taken to prevent the start or spreading of wildfires that may result from project activities. Firebreaks or guards shall be constructed and maintained.

All public access or haul roads used by the contractor during construction of the project shall be treated to fully suppress dust. All dust control methods shall ensure safe construction operations at all times. If chemical dust suppressants are applied, the material shall be a commercially available product specifically designed for dust suppression and the application shall follow manufacturer's requirements and recommendations. A copy of the product data sheet and manufacturer's recommended application procedures shall be provided to the technician before the first application.

5. MAINTENANCE, REMOVAL, AND RESTORATION

All pollution control measures and temporary works shall be adequately maintained in a functional condition for the duration of the construction period. All temporary measures shall be removed and the site restored to near original condition.

All equipment used within the construction site shall be well maintained. All equipment lines and fittings shall be checked on a daily basis to ensure that they are in good working order.

WISCONSIN CONSTRUCTION SPECIFICATION

7. Mobilization and Demobilization

1. SCOPE

The work consists of the mobilization and demobilization of the Contractor's forces and equipment necessary for performing the work required.

2. EQUIPMENT AND MATERIAL

Mobilization shall include:

- All activities and associated costs for transportation of the Contractor's personnel, equipment, and operating supplies to the site;
- Establishment of offices, buildings, and other necessary general facilities for the Contractor's operations at the site
- Premiums paid for performance and payment bonds including coinsurance and reinsurance agreements as applicable
- Construction and maintenance of haul roads and equipment parking areas
- Other job related items

Demobilization shall include:

- All activities and costs for transportation of personnel, equipment, and supplies not utilized in the project from the site
- Disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site.
- Repair of access roads, temporary haul roads, and equipment parking areas leaving the project site in the same or better condition than at the start of the project.
- General cleanup and house keeping needed to restore a neat and orderly project site.

Access to the site, equipment parking, and staging areas are limited to that shown on the drawings or as approved by the technician.

WISCONSIN CONSTRUCTION SPECIFICATION

8. Drainfill

1. SCOPE

The work shall consist of furnishing and placing the required drainfill as shown on the drawings.

2. MATERIALS

Drainfill materials shall be sand, gravel, crushed stone, or mixtures thereof. The material shall be clean, hard, durable particles free from organic matter or other deleterious substances that would interfere with free-draining properties.

3. GRADATION

The gradation of the drainfill shall be in accordance with the following:

a. The gradation of the material shall be as shown on the drawings.

b. If the gradation is not shown on the drawings, the material shall be a reasonably well graded sand-gravel mixture with 50 to 85 percent passing a No. 4 sieve. The maximum size of the material shall be 3 inches. No more than 5 percent by weight shall pass a No. 200 sieve.

c. Unless otherwise specified, not more than 5 percent by weight of the material finer than a No. 4 sieve shall be crushed limestone or dolomite.

4. BASE PREPARATION

Drainfill shall not be placed on the subgrade or over a pipe or drain tile until they have been inspected and approved by the Technician.

Required excavations shall be accomplished as shown on the drawings and in accordance with Wisconsin Construction Specification 2, Excavation.

Foundation surfaces and trenches shall be clean and free of organic matter, loose soil, foreign substances, and standing water when the drainfill is placed. Earth surfaces upon or against which drainfill will be placed shall not be scarified.

5. PLACEMENT

Drainfill shall be placed in uniform layers not more than 12 inches in thickness. When compaction is required and accomplished by manually controlled equipment, the layers shall be a maximum of 8 inches thick prior to compaction or as shown on the drawings.

The drainfill shall be placed in a manner to avoid segregation of particle sizes. No foreign materials will be allowed to become intermixed with or otherwise contaminate the material.

Any damage to the foundation surface or to the sides or bottoms of trenches occurring during placement of drainfill material shall be repaired before proceeding with the work.

The upper surface of drains constructed concurrently with adjacent zones of earthfill shall be maintained at or above the surface of the adjacent fill.

Drainfill placed over or around conduits shall be placed in a manner to avoid any displacement in line or grade of the pipe.

Drainfill shall not be placed adjacent to concrete structures until the concrete has cured for a minimum of 7 days.

6. COMPACTION

Unless otherwise stated on the drawings, no compaction will be required beyond that resulting from the placing and spreading operations.

When compaction is required, the methods stated in Wisconsin Construction Specification 3, Earthfill, shall be adhered to. The drainfill material shall be thoroughly wetted prior to equipment or manually controlled compaction.

WISCONSIN CONSTRUCTION SPECIFICATION

9. ROCK RIPRAP

1. SCOPE

The work shall consist of testing, furnishing, transporting, and placing rock riprap, including filter, bedding or geotextile materials where specified, in the construction of loose rock riprap revetments, blankets, rock toes, crossings, rock chutes, channel linings and other similar structures.

2. QUALITY OF MATERIALS

The rock shall be obtained from tested sources unless exempted below. Rock sources used for streambank protection, lined waterways, rock chutes, or other similar major projects (Job Class II and above) shall be tested prior to use. A test is required a minimum of every ten (10) years. The Technician may require a more current test.

Rock riprap from igneous or metamorphic origins such as granite, basalt, and quartzite may be used without testing. Dolomite from quarries within the map legend units shown in Figure 1 may also be used without testing:

- Dolomite (Sd) - all counties.
- Sinnipee Group (Os) and Prairie du Chien (Opc) exempt only in the following counties: Marinette, Oconto, Shawano, Brown, Outagamie, Calumet, Winnebago, Green Lake, and Fond du Lac.

The Technician shall inspect and approve sources of these rock types prior to use and determine if testing is required.

Rock for equipment or cattle channel crossings, access roads, heavy use area protection or similar minor structures need not be tested.

Individual rock fragments shall be dense, sound and free from cracks, seams and other defects conducive to accelerated weathering. The rock fragments shall be angular to subrounded in shape. The least dimension of each individual rock fragment shall be not less than one-third the greatest dimension of the fragment. It should also be free from dirt, clay, sand, rock fines and other materials not meeting the gradation limits. Rock shall be excavated, selected and handled as necessary to meet the grading requirements stated in the construction plans.

Representative samples of rock requiring testing shall conform to the following requirements:

Bulk Specific Gravity (saturated surface-dry basis). Not less than 2.50 when tested in accordance with ASTM Specification C 127 on samples prepared as described for soundness testing.

Absorption. Not more than four (4.0) percent when tested in accordance with ASTM C 127 on samples prepared as described for soundness testing.

Soundness. The weight loss in five cycles shall not be more than 28 percent when tested by the sodium sulfate soundness test method in the modified ASTM C 88. Losses in excess of 20 percent are acceptable only when the design D_{50} rock size has been increased by 10 percent for a loss of 20-23.9 percent or 20 percent for a loss of 24-28 percent.

3. METHODS OF TESTING

Bulk Specific Gravity and Absorption shall be determined by ASTM C 127 on samples prepared as described for rock cube soundness testing.

Rock Cube Soundness. Soundness testing shall be performed by ASTM C 88 for coarse aggregate modified as follows.

The sodium sulfate soundness test shall be performed on a test sample of 5000 ± 300 grams of rock fragments, reasonably uniform in size and cubical in shape and weighing, after sampling, approximately 100 grams each. The test sample shall be obtained from rock samples that are representative of the total rock mass, as noted in ASTM Specification D 4992, and that have been sawed into slabs as described in ASTM Specification D 5121. The samples shall be further reduced in size by sawing the slabs into cubic blocks. The thickness of the slabs and the size of the sawed blocks shall be determined by the size of the available test apparatus and as necessary to provide, after sawing, the approximate 100 gram samples.

Due to internal defects, some of the cubes may break during the sawing process or during the initial soaking period. Cubes that break during this preparatory process shall not be tested. Such breakage, including an approximation of the percentage of cubes that break, shall be noted in the test report.

After the sample has been dried, following completion of the final test cycle and washing to remove the sodium sulfate, the loss of weight shall be determined by subtracting from the original weight of the sample the final weight of all fragments which have not broken into three or more fragments. (Samples that break into three or more large fragments during testing will be assigned a final weight of 0.0.) The test report shall show the percentage loss of the weight. Photographic documentation of all samples before and after testing shall be part of the test report.

Equivalent AASHTO testing specifications may be substituted for ASTM testing specifications.

A rock source may be rejected if the rock from that source deteriorates in less than 5 years under similar use and exposure conditions expected for the rock to be installed under this specification, even though it meets the testing requirements stated above.

Deterioration is defined as the visual loss of more than one-quarter of the original rock volume, or severe cracking that would cause a rock to split.

4. GRADATION

The gradation of the rock riprap and filter or bedding material shall be as shown in the construction plans.

Rock used for streambank protection, lined waterways, rock chutes, or other similar major projects (Job Class II and above) shall have a gradation verification be done by one of the following methods.

Method A
Measurement of a random truck load of stone (reference sample) according to the procedure outlined in EFH-17, Procedure for Determining Rock Weights, Sizes, and Gradations; or ASTM D5519, Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials (Test Method A).

Method B
Creation of reference samples of rock of at least 0.5 tons, made according to the procedure outlined in EFH-17 (Tables 1 - 5), creating the envelope limits of the gradation specified.

Control of project gradation will be by visual inspection comparing rock delivered to the reference samples.

The reference sample(s) may be used as part of the finished riprap or remain at the quarry.

Any difference of opinion between the Technician and the Contractor shall be resolved by dumping and checking (by measurement) the gradation of a random truck load of stone by Method A. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost.

5. SUBGRADE PREPARATION

The subgrade surfaces on which the riprap, filter or bedding material is to be placed shall be cut or filled and graded to the lines and grades as shown on the drawings or as directed by the Technician. When fill to subgrade lines is required, it shall consist of approved materials and shall be compacted as specified in Wisconsin Construction Specification 3, Earthfill. Riprap, filter, bedding or geotextile shall not be placed until the foundation preparation is completed, and approved by the Technician.

6. FILTER AND BEDDING

Filter or bedding material, when required, shall be spread uniformly on the prepared subgrade surfaces to the depth shown on the drawings. The surfaces of the layers shall be finished reasonably free of mounds, dips or windrows and shall meet the gradation shown on the plans or as specified in Wisconsin Construction Specification 8.

Geotextile, when required, shall meet the requirements shown on the drawings and as specified in Wisconsin Construction Specification 13, Geotextiles.

7. PLACING ROCK RIPRAP

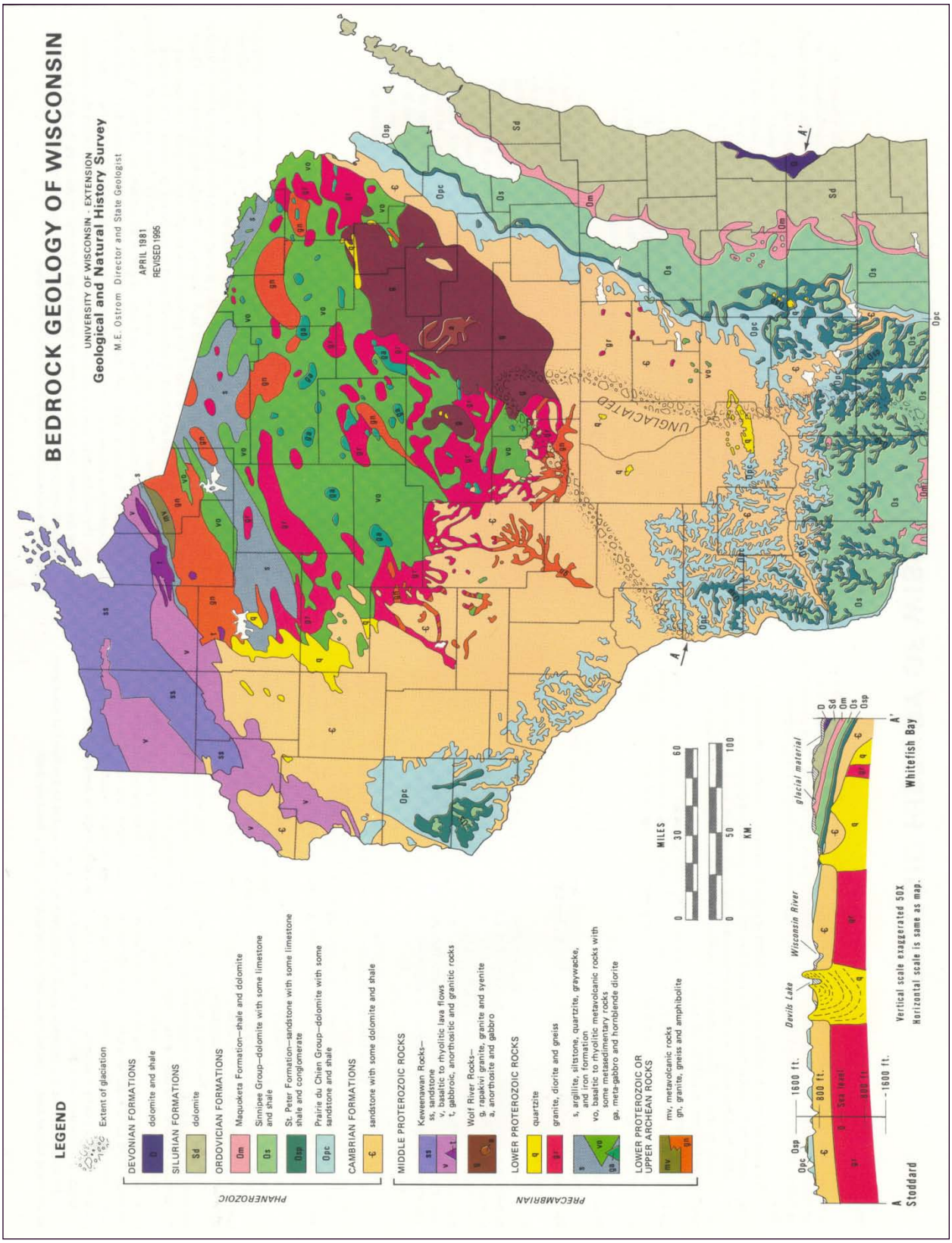
The rock riprap shall be placed by equipment on the surfaces and to the depths specified. The rock riprap shall be installed to the full course thickness in one operation and in such a manner as to avoid displacement of underlying materials. The rock for riprap shall be delivered and placed in a manner that will ensure that the riprap in-place shall be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks. Some hand placing may be required to provide a neat and uniform surface or to prevent damage to structures.

8. VEGETATED ROCK RIPRAP

If the rock riprap is to be vegetated, topsoil shall be placed by equipment in the riprap voids (surface) and on the surface of the rock to the depth specified. The topsoil placement shall not take place before the placement of the rock riprap is approved by the Technician. Topsoil shall be placed in such a manner as to avoid displacement of the underlying rock.

The topsoil may extend from the top of the riprap down to the bankfull elevation (OHWM) or as shown on the drawings. Care shall be taken so topsoil is retained on the rock and is not allowed into the water body. The area shall be seeded and mulched within 12 hours following topsoil placement.

Figure 1


BEDROCK GEOLOGY OF WISCONSIN
UNIVERSITY OF WISCONSIN - EXTENSION
Geological and Natural History Survey
M.E. Ostrom Director and State Geologist
APRIL 1981
REVISED 1995
LEGEND
Extent of glaciation
PHANEROZOIC
DEVONIAN FORMATIONS
D dolomite and shale
SILURIAN FORMATIONS
Sd dolomite
ORDOVICIAN FORMATIONS
Om Maquoketa Formation—shale and dolomite
Os Sinnipee Group—dolomite with some limestone and shale
Osp St. Peter Formation—sandstone with some limestone shale and conglomerate
Opc Prairie du Chien Group—dolomite with some sandstone and shale
CAMBRIAN FORMATIONS
Є sandstone with some dolomite and shale
PRECAMBRIAN
MIDDLE PROTEROZOIC ROCKS
Keweenawan Rocks—
ss, sandstone
v, basaltic to rhyolitic lava flows
t, gabbroic, anorthositic and granitic rocks
Wolf River Rocks—
g, rapakivi granite, granite and syenite
a, anorthosite and gabbro
LOWER PROTEROZOIC ROCKS
q quartzite
gr granite, diorite and gneiss
s, argillite, siltstone, quartzite, graywacke, and iron formation
vo, basaltic to rhyolitic metavolcanic rocks with some metasedimentary rocks
ga, meta-gabbro and hornblende diorite
LOWER PROTEROZOIC OR UPPER ARCHEAN ROCKS
mv, metavolcanic rocks
gn, granite, gneiss and amphibolite
UNGLACIATED
MILES
KM.
A
A'
Devils Lake
Wisconsin River
glacial material
1600 ft.
800 ft.
Sea level
Stoddard
Whitefish Bay
Vertical scale exaggerated 50X
Horizontal scale is same as map.

WISCONSIN CONSTRUCTION SPECIFICATION

10. Fences

PART I: STANDARD BARBED WIRE FENCE (SBWF)

1. SCOPE

The work shall consist of furnishing all materials required and installation of the fence at the locations shown on the plans. Part I of this specification applies to standard barbed wire fence (SBWF). Refer to Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence, Table 1 for minimum fence height, number of wires, and wire spacing.

Standard barbed wire fences (SBWF) shall have a minimum of three strands of barbed wire (interior fence only).

2. MATERIALS

A. Wire.

Wire shall conform to the requirements of ASTM A 121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire with Class 3 galvanizing meeting ASTM 641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire. The wire will be new and consist of 2 twisted strands of 12.5-gauge steel wire with Class 3 galvanizing or 2 twisted strands of 15.5-gauge high tensile wire with Class 3 galvanizing. The barbs shall be minimum 2 point on 5-inch centers.

B. Fasteners.

(1) Staples shall be 9-gauge, Class 3 galvanized steel or heavier with a minimum length of 1.75 inches for softwoods and a minimum length of 1 inch for close-grained hardwoods.

(2) Manufacturer's clips or 14-gauge wire may be used to fasten wires to steel posts.

C. Posts.

(1) Wood.

All wooden posts and brace members (except red and white cedar, tamarack, osage orange, black locust, and white oak) shall be treated by a method listed in Table 1, and ensure that complete penetration of the sapwood is obtained. All bark shall be removed from the cedar, tamarack, osage orange, black locust, and white oak. At least one-half the diameter of cedar shall be heartwood. The quality of treated wood shall provide sufficient strength and last for the expected life of the fence.

Unless otherwise specified, minimum preservation retention values shall be as listed in Table 1.

Table 1
Preservative Treatment Method and Minimum Retention

Treatment Method	Retention (lbs./ft.^{3})
Creosote Solution	8.00
Copper Naphthenate	0.055
Pentachlorophenol	0.40
Ammoniacal Copper Arsenate (ACA)	0.40
Chromated Copper Arsenate (CCA), Type A, B, or C	0.40
Micronized Copper Azole (MCA)	0.15
Micronized Copper Quaternary (MCQ)	0.34
Alkaline Copper Quaternary (ACQ or AC2)	0.40

All corner, end, pull, and gate assembly posts shall be wooden with a minimum top diameter of 5 inches.

Wooden line posts shall have a minimum 4-inch diameter.

(2) Steel.

Steel line posts shall have the standard "T" section, and nominal dimensions of 1⅜ inches by 1⅜ inches by ⅛ inch with anchor plate. The posts shall be rolled from high carbon steel, weigh at least 1.25 pounds per foot of length, and shall be painted with a weather resistant paint for steel, enameled and baked, or hot dip galvanized. The posts shall be studded to aid in wire attachment.

(3) Other.

Other materials may be used for corner, end, gate assembly, line posts, and brace members if they are of equal or greater strength and quality of above. They must be preapproved by the technician.

3. INSTALLATION

A. Post Installation and Spacings.

Post spacing for line posts shall not exceed 16 feet for standard barbed wire fence and 25 feet for high tensile barbed wire fence.

B. Corner, End, Pull, and Gate Assemblies.

One of the following braces will be used:

(1) A floating diagonal brace or H-brace is required on corners or ends.

(2) H-bracing is required at all pull assemblies and must be installed every 660 feet maximum.

Wood horizontal or diagonal brace member shall be a minimum of 4 inches in diameter and a minimum of 7 feet in length, and 9 feet for diagonal braces. A tension wire composed of two complete loops of 9-gauge smooth wire, 12-gauge double strand wire, or a single loop of 12.5-gauge high tensile smooth wire shall be used for H-braces. One end of the tension member shall be at the height of the horizontal brace member and the other end shall be 4 inches above the ground line on the other post.

If the posts are to be set or driven to a 3-foot depth or more below the ground line, a single H-brace assembly may be used. Otherwise, a double H-brace assembly shall be used.

A corner assembly shall be used wherever the horizontal alignment changes more than 15 degrees and/or where vertical alignment changes more than 15 degrees.

C. Line Post.

Wooden line posts shall be set or driven a minimum of 24 inches below the ground line. Steel line posts shall be set or driven a minimum of 18 inches below the ground line. If posts are not driven, the backfill around the post shall be well compacted.

D. Fastening.

The top wire shall be at least 2 inches below the top of a wooden post, and 1 inch below the top of a steel post. The tension on the high tensile barbed wire should be 200 to 250 pounds on each wire. Tension will be applied with an in-line stretcher on each strand. To gauge tension, install a tension spring on at least one strand of wire. All wires shall be attached to each line post.

Staples shall be driven diagonally to the wood's grain and at a slight downward angle, (upward if pull is up) to avoid splitting the post and loosening of the staples. Space should be left between the inside crown of the staple and post to permit free movement of high tensile barbed wire. Barbed staples shall be used for wooden posts.

Wires shall be attached to steel posts using manufacturer's clips or by two turns of 14-gauge galvanized wire.

Wire shall be spliced by means of a Western Union splice or by suitable splice sleeves applied with a tool designed for the purpose. The Western Union splice shall have not less than 8 wraps at each end about the other. All wraps shall be tightly wound and closely spaced.

PART II: HIGH TENSILE PERMANENT ELECTRIC WIRE FENCE (HTPEWF) AND HIGH TENSILE NON-ELECTRIC WIRE FENCE (HTNEWF)

1. SCOPE

The work shall consist of furnishing all materials required and installation of the fence at the locations shown on the plans. Part II of this specification applies to high tensile permanent electric wire fence (HTPEWF) and high tensile non-electric wire fence (HTNEWF). Refer to Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence, Table 1 for minimum fence height, number of wires, and wire spacing.

High tensile non-electric wire fence (HTNEWF) shall have a minimum of four strands of high tensile smooth wire (interior fence only). The minimum number of wires is dependent on the use of the fence.

High tensile electric wire fence shall have a minimum of one strand of high tensile smooth wire (interior fence only). The minimum number of wires is dependent on the use of the fence.

Barbed wire shall not be used on electric fences because of the safety hazard created by the high capacity energizers needed to charge the heavy gauge wire.

2. MATERIALS

A. Wire.

The wire will be new, smooth, and meet or exceed the following:

- Gauge – 12.5
- Tensile Strength – 140,000 psi (minimum)
- Galvanizing – Class 3
- Breaking Strength – 900 lbs. (minimum)
- ASTM A 854, Metallic-Coated Steel Smooth High-Tensile Fence and Trellis Wire
- ASTM A 854, Metallic-Coated Steel Smooth High-Tensile Wire Core with UV-Resistant, White, Electrically Conducive Polymer Coating.

B. Fasteners.

(1) Staples shall be of 9-gauge galvanized steel or heavier with a minimum length of 1.75 inches for softwoods and a minimum length of 1 inch for close-grained hardwoods.

(2) Manufacturer's clips or 14-gauge Class 3 galvanized wire meeting the appropriate ASTM for the fencing material specified may be used to fasten wires to steel, plastic/composite, or fiberglass posts.

C. Posts.

(1) Wood.

All wooden posts and brace members (except red or white cedar, tamarack, osage orange, black locust, and white oak) shall be treated by a method listed in the table below to ensure that complete penetration of the sapwood is obtained. All bark shall be removed from the cedar, osage orange, black locust, and white oak. At least half the diameter of cedar shall be

heartwood. The quality of treated wood shall provide sufficient strength and last for the expected life of the fence.

Unless otherwise specified, minimum preservative retention values shall be as listed in Table 2.

Table 2
Preservative Treatment Method and Minimum Retention

Treatment Method	Retention (lbs./ft.^{3})
Creosote Solution	8.00
Copper Naphthenate	0.055
Pentachlorophenol	0.40
Ammoniacal Copper Arsenate (ACA)	0.40
Chromated Copper Arsenate (CCA), Type A, B, or C	0.40
Micronized Copper Azole (MCA)	0.15
Micronized Copper Quaternary (MCQ)	0.34
Alkaline Copper Quaternary (ACQ or AC2)	0.40

All corner, end, and gate assembly posts shall be wooden with a minimum top diameter of 5 inches. Assembly posts shall be a minimum of 8 feet long for single H-brace assemblies.

Wooden line posts shall have a minimum 4-inch diameter (2 ½-inch for osage orange).

(2) Plastic/Composite.

Plastic/composite line posts shall be at least 1 inch in diameter, have a manufacturer's warranty, and be durable for the life of the fence. All plastic/composite posts shall be UV protected for the life of the fence. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

(3) Steel.

Steel line posts shall have the standard "T" section, nominal dimensions of 1⅜ inches by 1⅜ inches by ⅛ inch with anchor plate. The posts shall be rolled from high carbon steel, weigh at least 1.25 pounds per foot of length and shall be painted with a weather resistant paint for steel, enameled and baked, or hot dip galvanized. The posts shall be studded to aid in wire attachment.

(4) Fiberglass.

Fiberglass reinforced posts must be at least ⅞-inch diameter, or fiberglass reinforced T-post at least 1-inch cross-section and have a manufacturer's warranty and be durable for the life of the fence. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

(5) Other.

Other materials may be used for corner, end, gate assembly, line posts, and brace members if

they are of equal or greater strength and quality of above. They must be preapproved by the technician.

3. INSTALLATION

A. Post Installation and Spacings.

Live trees are not acceptable to use as posts.

Post spacing for line posts shall be a maximum of 50 feet for interior electric fence (except for a lane fence when it shall be 70 feet), or 30 feet for perimeter electric fence, except when stays are placed every 33 feet (then, the maximum post spacing shall be 100 feet). On sites where the land slope is less than 5 percent, a 50-foot maximum post spacing may be used for perimeter fence posts. For high tensile non-electric fence, the maximum post spacing shall be 12 feet if the fence is used to restrain animals.

B. Corner, End, and Gate Assemblies.

Brace assemblies are required at all corners, gates, pull, and end assemblies.

One of the following assemblies shall be used for all corners, ends, and gates:

(1) A floating diagonal brace.

(2) An H-brace.

(3) A substantial corner post. Corner posts are to be set or driven to a minimum of 4 feet below the ground line.

All brace members shall be wood and the horizontal member centerline shall be 4 to 9 inches below the top of the post. Other brace material of equal strength may be used with the preapproval of the technician. Floating diagonal braces shall be placed at ⅔ the height of the fence, measured from the bottom wire up.

Wood horizontal brace members shall be a minimum of 3 inches in diameter and a minimum of 7 feet in length, 9 feet for floating diagonal braces. A tension wire composed of two complete loops of 9-gauge smooth wire, 12-gauge double strand wire, or a single loop of 12.5-gauge high tensile strength smooth wire shall be used. One end of the tension member shall be at the height of the horizontal brace member and the other end shall be 4 inches above the ground line on the other post.

If the posts are set or driven to 3 feet or more below the ground line, a single H-brace assembly or floating diagonal brace may be used. Otherwise a double H-brace assembly shall be used.

A corner assembly shall be used when the horizontal alignment changes more than 30 degrees.

C. Line Post.

Wood, fiberglass, steel, and plastic/composite posts for HTNEWF shall be set or driven a minimum of 24 inches below the ground line for single or multiple wire fences. Wood posts for HTPEWF shall be driven a minimum of 24 inches below the ground line for single or multiple wire fences. Fiberglass, steel, and plastic/composite posts for HTPEWF shall be set or driven to a minimum of 12 inches below the ground line for a single wire fence and a minimum of 18 inches below the ground line for a multiple wire fence.

If posts are not driven, the backfill around the post shall be well compacted.

In areas where soil depth restricts the post embedment depth, additional anchors or deadman applied against the direction of pull shall be used.

D. Fastening.

The top wire shall be at least 2 inches below the top of the wooden post and 1 inch below the top of all other posts. Tension will be applied with an in-line stretcher or other tightener on each strand to achieve no visible sag. All wires shall be fastened to each line post.

Staples shall be driven diagonally to the wood's grain and at a slight downward angle (upward if pull is up) to avoid splitting the post and loosening of the staples. Space should be left between the inside crown of the staple and post to permit free movement of high tensile wire. Barbed staples shall be used for wood posts.

Wire shall be attached to steel, fiberglass, and plastic/composite posts using manufacturer's clips or two turns of 14-gauge galvanized wire.

The staples, wires, and clips should allow free movement of the high tensile fence wire.

Wire shall be spliced by means of a manufacturer's recommended splice or knot, or by suitable splice sleeves applied with a tool designed for the purpose.

E. Interior Fences.

For 1-wire electric or other temporary interior fences a brace is not required at corners, gates, pull, and end assemblies.

F. Offset Brackets.

Offset brackets made of galvanized high tensile spring wire with insulator of high density polyethylene with ultra-violet stabilizer or porcelain can be attached to standard barbed wire fence or woven wire fence to provide a transmission line and/or to protect a standard fence. Place the offset brackets no further than 60 feet apart and attach to the wires of the standard fence next to the post. Place offset brackets at chest height of the animals to be controlled. Ensure that no wires of any existing fence comes in contact with the electric fence wire, as an electrical short will occur.

4. LIGHTENING PROTECTION

Lightening protection is required for all electrified fences. Follow the fence energizer manufacturer's recommendations.

5. ADDITIONAL SPECIFICATIONS FOR HTPEWF

A. Energizers.

(1) Power Source.

Electronic energizers or power fence controllers shall be installed according to the manufacturer's recommendations and will meet the following minimum specifications:

- High power, low impedance system with solid state circuitry capable of at least 5,000 volt peak output and a short pulse that is less than 300 mAmps in intensity, finished within .0003 of a second and a rate of 35-65 pulses per minute.
- High impact weather resistant cases.
- 110 volt, 220 volt conventional powered electric fence energizers.
- 12-volt battery powered capable of operating three weeks without recharging. If the length of fence requires an energizer of more than 4 joules, a solar charger will be needed on the battery systems.
- Minimum voltage output by livestock species:
  - cattle: 3000v
  - sheep and goats: 4000v
  - hogs and horses: 2000v
- Utilize a safety pace fuse to prevent over pulsing.

(2) Size.

Under normal operating conditions, the energizer should be capable, at a minimum, of producing 1 joule of energy for each mile of wire used. (Joules are units of electrical energy. One joule does about 0.74 ft-lb. of work. Watts x seconds = joules.) If a significant portion of the fence will be exposed to dense vegetation, additional energy requirements may be needed.

B. Grounding.

All electric fences must be properly grounded. The energizer ground wire shall be connected to a galvanized pipe or rod 0.5 inch or larger in diameter. A minimum of 3 feet of ground rod for each joule of energy output shall be installed to properly ground the fence.

Ground rods shall be placed where soil remains moist for best results. Drive a sufficient number of 6- to 8-foot long rods into the soil 10 feet apart to provide the required length of ground rod exposure to the soil. Connect a continuous ground wire from the energizer to each rod. The energizer terminals, ground wire, and ground rods shall be made of the same material (steel to steel, copper to copper) to prevent accelerated corrosion which could cause a loss of electric continuity.

Additional ground rods may be needed for the system to function properly. Follow the manufacturer's recommendations where they exceed the requirements of this standard.

The ground wire(s) of the fence may be connected to the same grounding system as the energizer or a separate grounding system. Where a combined grounding system is used, the design shall meet or exceed the minimum design criteria specified for both the energizer and lightening protector.

Do not use the grounding system for other existing applications, such as power poles, breaker boxes, and milk barns. At least 65 feet shall separate the fence grounding system from any other electrical grounding system.

C. Spike Protector.

A voltage spike protector is recommended for use with 120 and 140-volt energizers. Also, a ground rod shall be installed at the electric company's transformer pole (primary ground) and another ground rod installed at the electrical circuit breaker box (secondary ground), if they do not exist at the time of electric fence construction. Additionally, a surge protector shall be installed between the energizer and power supply.

D. Insulation and Insulated Cable.

Insulation used for positively charged wire(s) must be high-density polyethylene with ultra-violet stabilizer.

All underground wire(s) installations must be double insulated; molded; high tensile strength steel, 12.5-gauge or larger wire. The insulation must be high density polyethylene or polypropylene with ultra-violet stabilizer.

Insulators for steel and other conductive material posts shall be capable of withstanding at least 10,000 volts of current leakage and shall be made of high-density polyethylene with ultra-violet stabilizer or porcelain.

Insulators for end, corner, and angle braces shall be capable of withstanding at least 10,000 volts of current leakage and shall be made of high-density polyethylene with ultra-violet stabilizer, high-density polypropylene with ultra-violet stabilizer, or porcelain. Red insulators should not be used as they might attract hummingbirds.

Use insulated galvanized wire to cross gates and areas where electrical shocks to humans and livestock should be prevented (e.g., working facilities). For underground burial, use wire designed for burial. Placing buried cable inside plastic pipe helps to decrease the incidence of short-circuiting. Do not use insulated copper wire due to the potential for corrosion at the splice and a lack of tensile strength.

E. Gates.

(1) Electrified Gates.

Electrified gates may be constructed of a single straight wire, galvanized cable, polytape or electrified rope with a spring loaded insulated handle, or an expandable, coiled, high tensile, 12.5-gauge wire attached to an insulated handle. The number of wires shall be determined by the fence objective. The gate shall be constructed so that it is non-electrified when the gate is open. Overhead or underground transmission lines will be used to carry electricity past the gate to the remainder of the fence.

(2) Flood Gates.

An electrified floodgate may be used in lieu of a non-electrified gate if desired. The electrified floodgate is constructed by stretching an electrified wire across the drainage above high water flow level. Attach droppers of 12.5-gauge high tensile fence wire, galvanized cable, or galvanized chains to the electrified wire at a spacing of 6 inches above average normal water level. Connect gate to electric fence with double insulated cable through a cut-off switch and floodgate controller. If flooding is expected for extended periods of time, switch the floodgate off.

6. ADDITIONAL SPECIFICATIONS FOR HTNEWF

A. Grounding for Lightening Protection.

Non-electrical wire fences using wood posts shall be grounded at least every quarter mile. Ground rods should be driven not less than 4 feet into the ground. The rods shall be galvanized steel and a minimum of 0.5 inch in diameter. All line wires of the fence must be grounded.

Part III: TEMPORARY ELECTRIC FENCE (TEF)

1. SCOPE

The work shall consist of furnishing all materials required and installation of the fence at the locations shown on the plans. Part III of this specification applies to Interior Temporary Electric Fence (TEF). Refer to Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence, Table 1 for minimum interior electric fence height and number of wires.

2. MATERIALS

All materials provided shall be durable for the intended use and life of the fence. Materials that fail prior to the end of the practice lifespan established by the design shall be replaced with equal or higher quality fencing materials.

A. Wire

Poly-wire, poly-tape, or poly-rope shall have a minimum or 6 strands of stainless steel wire filament and be made with UV stabilized polyethylene. Steel wire filaments shall be 14 gauge or larger. Stainless steel wire filaments shall be a minimum of 19 gauge. Aluminum wire shall not be used.

A minimum of two reels of poly-wire are needed for sub-dividing pastures. In strip-grazing systems with a “back fence”, 3 reels are more convenient. Poly-wire is typically sold on reels containing 660 or 1320 feet of fence.

Energized netting may be used for livestock that will not be controlled by a single strand interior electric temporary fence. Energized netting shall be constructed of UV stabilized polyethylene.

B. Fasteners

Manufacturer’s clips may be used to fasten wires to plastic/composite, or fiberglass posts.

Insulated gate handles, clips or jumpers may be used to attach the poly-wire fence to the adjoining permanent electric fence.

C. Line Posts

(1) Plastic Step-in Posts

All plastic or plastic coated posts shall be UV protected for the life of the fence. Step-in posts shall be made of durable plastic, plastic covered steel or fiberglass. Plastic posts shall have a steel pin at least 4 inches long. Smaller pins are easier to get into the ground during dry and frozen periods. Step-in posts shall have a manufacturer's warranty and be durable for the life of the fence. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

(2) Fiberglass Posts

Fiberglass posts shall be at least 3/8 inch in diameter. All fiberglass post shall be UV protected for the life of the fence. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

(3) Steel Pig-tail Insulated Posts

Steel Pig-tail posts shall be at least 3/8 inch in diameter with a UV protected plastic insulator coating over the entire surface or the post that may be contacted by the poly-tape. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

3. INSTALLATION

A. Post Installation and Spacing

Post shall be spaced a maximum of 50 feet. Add more posts for uneven terrain.

B. Fastening

Poly-wire shall be attached to fiberglass posts using manufacturer's clips.

Poly-wire shall be attached to Step-in posts by inserting the poly-wire into the clip or loop molded onto the body of the post.

Poly-wire shall be attached to Pig-tail posts by inserting the poly-wire through the open loop on the top of the post.

Electric gate handles should be used to attach temporary poly-wire to electric sources such as an exterior high-tensile electric fence wire. These are typically attached to the end of the poly-wire on the reel. Most reels can be hung on the opposite reach on a high tensile fence wire. Insulated clips or jumpers may also be used to attach the poly-wire to the adjoining electric fence.

C. Fence Height and Number of Wires

Poly-wire fences will typically be installed at a 30 inch height measured from the ground surface Multiple wires or a different top wire height may be necessary based on the fence design requirements found in Table 1of the Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence.

PART IV: WOVEN WIRE FENCE (WWF)

1. SCOPE

The work shall consist of furnishing all materials required and installation of the fence at the locations shown on the plans. Part III of this specification applies to woven wire fence (WWF). Refer to Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence, Table 1 for minimum fence height and wire spacing.

Standard woven wire fence (SWFF) shall consist of low-carbon steel woven wire with a single or multiple strands of either barbed wire or high tensile smooth wire with a minimum spacing of 2 to 6 inches starting at the top of the woven wire.

High tensile woven wire fence (HTWWF) shall consist of fixed knot or hinge joint high tensile woven wire with a single or multi strands of smooth high tensile wire, or high tensile barbed wire, 2 to 6 inches above the top of the woven wire. HTWWF may be electrified (see power requirements for electric fence). The bottom of the fence should be placed 7 inches above ground with a barbed wire along the ground.

Specialty high tensile woven wire fence (SHTWWF) shall consist of 49- to 96-inch high woven wire with a single strand of smooth high tensile wire, or high tensile barbed wire, 2 to 6 inches above the top of the woven wire. This type of fence is intended for deer, elk, and exotic animals.

2. MATERIALS

A. Wire.

SWWF shall be made from low-carbon steel wire with Class 3 galvanizing meeting ASTM A 641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, and conform to the requirements of ASTM A 116, Metallic-Coated, Steel Woven Wire Fence Fabric. The woven wire shall have the top and bottom strands 10-gauge or heavier. The intermediate and stay wires shall be 14.5-gauge or heavier. The stay wires shall be spaced a maximum of 12 inches apart.

HTWWF and SHTWWF will be made from high tensile steel wire with Class 3 galvanizing meeting ASTM A 641, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, and conform to the requirements of ASTM A 116, Metallic-Coated, Steel Woven Wire Fence Fabric. The top and bottom strands of the woven wire shall be 12.5-gauge or heavier. The intermediate and stay wires shall be 14.5-gauge or heavier. The stay wires shall be spaced a maximum of 12 inches apart for non-electric woven wire, and 24 inches when the wire is electrified.

Barbed wire used with SWWF and HTWWF shall meet the requirements of Part I of this specification, Standard Barbed Wire Fence (SBWF).

High tensile wire used with SWWF, HTWWF, or SHWWF will be smooth and meet or exceed the following:

- Tensile Strength – 140,000 psi (minimum)
- Galvanizing – Class 3
- Gauge – 12.5
- Breaking Strength – 900 lbs. (minimum)

B. Fasteners.

(1) Staples shall be 9-gauge, Class 3 galvanized steel or heavier with a minimum length of 1.75 inches for softwoods and a minimum of 1 inch for close-grained hardwoods.

(2) Manufacturer's clips or 14-gauge, Class 3 galvanized wire may be used to fasten wires to steel posts.

C. Posts.

(1) Wood.

All wooden posts and brace members (except red or white cedar, tamarack, osage orange, black locust, and white oak) shall be treated by a method listed in the table below, and ensure that complete penetration of the sapwood is obtained. All bark shall be removed from the cedar, tamarack, osage orange, black locust, and white oak. At least one-half the diameter of cedar shall be heartwood. Quality of treated wood shall provide sufficient strength and last for the expected life of the fence.

Unless otherwise specified in the construction plan, minimum preservative retention values shall be as listed in Table 3.

Table 3
Preservative Treatment Method and Minimum Retention

Treatment Method	Retention (lbs./ft.^{3})
Creosote Solution	8.00
Copper Naphthenate	0.055
Pentachlorophenol	0.40
Ammoniacal Copper Arsenate (ACA)	0.40
Chromated Copper Arsenate (CCA), Type A, B, or C	0.40
Micronized Copper Azole (MCA)	0.15
Micronized Copper Quaternary (MCQ)	0.34
Alkaline Copper Quaternary (ACQ or AC2)	0.40

Corner, end, pull and gate assembly posts for HTWWF and SWWF shall be wooden with a minimum top diameter of 5 inches. Assembly posts shall be a minimum 7 feet long for single H-brace assemblies and for double H-brace assemblies. For SHTWWF, the length will depend upon the height of the fence and shall be as specified in the construction plan.

Bend assembly posts shall have a minimum top diameter of 4 inches and will be a minimum 7 feet long.

Wooden line posts shall have a minimum top diameter of 4 inches and shall be a minimum length of 7 feet. Fence posts for SHTWWF must be a minimum 5 inches in diameter.

(2) Plastic/Composite.

Plastic/composite line posts shall have a manufacturer's warranty, and be durable for the life of the fence. All plastic/composite line posts shall be UV protected for the life of the fence. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

Plastic/composite line posts for SHTWWF and HTWWF shall be at least 1⅛ inches in diameter. Plastic/composite line posts cannot be used with SWWF.

(3) Steel.

Steel line posts shall have the standard "T" section, and nominal dimensions of 1⅜ inches by 1⅜ inches by ⅛ inch with anchor plate. The posts shall be rolled from high carbon steel, weigh at least 1.25 pounds per foot of length, and shall be painted with a weather resistant paint for steel, enameled and baked, or hot dip galvanized. The posts shall be studded to aid in wire attachment. Steel line posts shall be a minimum length of 5 feet.

(4) Fiberglass.

Solid fiberglass reinforced posts must be at least 2 inches in diameter, have a manufacturer's warranty, and be durable for the life of the fence. Fence posts that are damaged or failing shall be replaced according to the Operation and Maintenance plan developed with the fence design.

(5) Other.

Other materials may be used for corner, end, gate assembly, line posts, and brace members if they are of equal or greater strength and quality than above. They must be preapproved by the technician.

3. INSTALLATION

A. Post Installation and Spacings.

Post spacing for line posts shall not exceed 16 feet for SWWF and SHTWWF and 25 feet for HTWWF. Corner posts shall be set or driven 3 feet below the ground line unless a restrictive layer prevents installation to the required depth.

B. Corner, End, Pull, and Gate Brace Assemblies.

Brace assemblies are required at all corners, gates, pulls and ends.

One of the following assemblies for all corners, ends, pulls and gates shall be used:

(1) A floating diagonal brace.

(2) If the posts are to be set or driven to 3 feet below the ground line, a single H-brace assembly may be used.

(3) If the posts are to be set or driven to less than 3 feet below the ground line, a double H-brace assembly shall be used.

All brace members shall be wood and the horizontal member centerline shall be 4 to 9 inches below the top of the post. Other brace material of equal strength may be used with the preapproval of the technician.

The horizontal brace member shall be a minimum 4 inches in diameter and a minimum 7 feet in length. A tension wire composed of 2 complete loops of 9-gauge smooth wire, or a single loop of 12.5-gauge high tensile smooth wire shall be used. One end of the tension wire shall be at the height of the horizontal cross brace member and the other end of the tension wire shall be 4 inches above the ground line on the other post.

A corner assembly or bend assembly shall be used when the horizontal alignment changes more than 15 degrees and a pull assembly shall be used when vertical alignment changes more than 15 degrees. A bend assembly will be used only when it will not affect the integrity of the fence. Post spacing for a bend assembly can be determined by placing 3 stakes, each spaced 14 feet apart, along the fence line. A string then is stretched between the first and third stake. A measurement then is taken from the second stake and the string. The spacing of the posts is determined in Table 4.

Table 4
Post Spacing

Distance Between String and Stake	Post Spacing
0 to 4 inches	14 feet
5 to 7 inches	12 feet
8 to 10 inches	10 feet
11 to 15 inches	8 feet
16 or more inches	6 feet

These bend assembly posts will be wood and set with a 6-inch lean from vertical to the outside of the curve, and set or driven 36 inches below ground line.

Pull assemblies for SWWF shall be installed at intervals not to exceed 660 feet. The continuity of the wire shall be interrupted at the pull assembly.

HTWWF and SHTWWF will not require the installation of pull assemblies.

C. Line Post.

Wooden and plastic/composite line posts shall be set or driven a minimum of 24 inches below the ground line. If soil depth is less than 24 inches, use standard “T” steel posts.

Steel line posts shall be set or driven a minimum of 18 inches below ground line.

If posts are not driven, the backfill around the post shall be well compacted.

In areas where soil depth restricts the embedment depth, additional anchors or deadman applied against the direction of the pull shall be used.

D. Fastening.

The top wire shall be at least 2 inches below the top of a wooden post and 1 inch below the top of all other types of post. Tension of the fence should be set such that the sag between posts is no more than 1 inch. The tension crimp should be half the size of an untensioned crimp when stretched. All horizontal wires shall be fastened to each line post.

Wire shall be attached to steel, fiberglass, and plastic/composite posts using manufacturer's clips or two turns of 14-gauge galvanized wire.

Staples shall be driven diagonally to the wood's grain and at a slight downward angle (upward if the pull is up) to avoid splitting the post and loosening of the staples. Space should be left between the inside crown of the staple and post to permit free movement of high tensile wire. Barbed staples shall be used for wood posts.

The staples, wires, and clips should allow free movement of the high tensile fence wire.

All wire shall be spliced by means of a crimp or suitable knot, or by suitable splice sleeves applied with a tool designed for the purpose. The splice shall have not less than 8 wraps at each end about the other. All wraps shall be tightly wound and closely spaced.

E. Grounding.

Fences using wood posts shall be grounded for lightening protection at least every quarter mile, with ground rods driven not less than 4 feet into the ground. The rods shall be galvanized steel and a minimum of 0.5 inch in diameter. All line wires of the fence must be grounded. Add 12.5-gauge wire for the lead-out wire.

PART V: CHAIN LINK FENCE (CLF)

1. SCOPE

The work shall consist of furnishing all materials required and installation of the fence at the locations shown on the plans. Part IV of this specification applies to chain link fence (CLF). Refer to Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence, Table 1 for minimum fence height and wire spacing.

2. MATERIALS

A. Chain Link Fence Fabric.

Chain link fence fabric shall be 9-gauge wire with a minimum tensile strength of 1,290 pounds. Chain link fence fabric shall conform to the requirements of ASTM A 392, "Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric," 2-inch woven mesh, and 9-gauge galvanized steel wire. Zinc coating shall be Class 2. Polymer coated chain link fence fabric shall conform to the requirements of ASTM F 668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric. Any damage to the coating shall be repaired in accordance with manufacturer's recommendations, or the damaged fencing material shall be replaced.

B. Posts and Fence Framework.

Posts and fence framework shall conform to the requirements of ASTM F 1043 "Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework," Group 1A, for Heavy Industrial Fence. Coatings shall be Type A galvanized for both internal and external surfaces. Any damage to the coating shall be repaired in accordance with manufacturer's recommendations, or the damaged fencing material shall be replaced.

C. Gates, Gateposts, and Gate Accessories.

Gates, gateposts, and gate accessories shall conform to the requirements of ASTM F 900, Standard Specification for Industrial and Commercial Swing Gates. Coating shall be the same as selected for adjoining fence and framework.

D. Top Rail and Gate Frames.

Top rail and gate frames shall be a minimum 1.66 inch outside diameter standard (Schedule 40) steel pipe or Grade B high strength steel.

E. Line Posts.

Line posts shall be a minimum of 1.9 inches outside diameter standard (Schedule 40) steel pipe or Grade B high strength steel and be of sufficient length to support the height of the fence.

F. Corner and End Posts.

Corner and end posts shall be a minimum of 2.375 inches outside diameter standard (Schedule 40) steel pipe or Grade B high strength steel, be of sufficient length to support the height of the fence, and be set in concrete.

G. Gate Posts

Gate posts shall be standard (Schedule 40) steel pipe or Grade B high strength steel, be set in concrete, and have the minimum O.D. listed below.

Minimum Post Size		
Fence Height (ft.)	Gate Leaf Width (ft.)	Post Size O.D. (in)
≤ 6	≤ 4	2.375
≤ 6	> 4 and ≤ 10	2.875
≤ 6	> 10 and ≤ 18	4.0
> 6	≤ 6	2.875
> 6	> 6 and ≤ 12	4.0
> 6	> 12 and ≤18	6.625
> 6	> 18 and ≤ 24	8.625
Reference: ASTM F567-Table 2, ASTM F900-Table 2		
Consult manufacturer on minimum post size needed if using privacy slats		

H. Fence Fittings.

Fence fittings shall conform to the requirements of ASTM F 626, "Standard Specification for Fence Fittings." Fittings shall be galvanized steel. Wire ties and clips shall be 9-gauge galvanized steel.

3. INSTALLATION

Installation shall be in accordance with the construction plans.

A. Post Installation.

All posts shall be capped immediately after installation. Where posts are installed in highly corrosive soils, the posts shall be vinyl coated in addition to the above requirements and set in concrete poured inside a clay tile or plastic tubing.

B. Braces and Top Rails.

Braces and top rails shall be installed horizontally at the height shown on the drawings or recommended by the manufacturer. Braces and top rails shall be attached to the posts by suitable fittings, as recommended by the manufacturer. A 7-gauge galvanized steel tension wire, meeting the appropriate ASTM for the fencing material specified, tightened by mechanical means, shall be placed approximately 4 inches from the ground level. A similar tension wire shall be placed at the top of the fence if a top rail is not used.

C. Chain Link Fabric.

Chain link fabric is generally installed on the outside of the fence post unless otherwise shown on the drawings. Fencing fabric shall not be stretched until at least 4 days after the posts are grouted into walls or 7 days after the posts are set in the concrete backfill or grouted into concrete walls. The fabric shall be stretched taut and securely fastened, using 9-gauge tie clips, to posts at intervals not exceeding 15 inches and to top rails or tension wires at intervals not exceeding 2 feet. Care shall be taken to equalize the tension on each side of each post.

A stretcher bar shall be used at terminal post locations.

D. Barbed Wire.

Barbed wire shall be installed as shown on the drawings and shall be pulled taut and fastened to each post or arm with the tie wires or metal tie clips.

E. Gate Frames.

Gate frames shall be fabricated and hung so they sag no more than 1 percent of the gate width.

PART VI: BOARD FENCE (BF)

1. SCOPE

The work shall consist of furnishing all materials required and installation of the fence at the locations shown on the plans. Part V of this specification applies to board fence (BF). Refer to Wisconsin NRCS Field Office Technical Guide, Section IV, Standard 382, Fence, Table 1 for minimum fence height, number of boards, and board spacing.

A board fence shall have a minimum of three boards.

2. MATERIALS

All materials provided shall be durable for the intended use and life of the fence.

A. Wood

All wood posts, boards (horizontal boards) and brace members (except red or white cedar, tamarack, osage orange, black locust, and white oak) shall be treated by a method listed in the table below to ensure that complete penetration of the sapwood is obtained. Boards may be painted with an exterior paint durable for the life of the fence in lieu of preservative treatment. All bark shall be removed from cedar, osage orange, black locust, and white oak. At least half the diameter of cedar shall be heartwood. The quality of treated wood shall provide sufficient strength and last for the expected life of the fence.

Unless otherwise specified, minimum preservative retention values shall be as listed in Table 5.

Table 5
Preservative Treatment Method and Minimum Retention

Treatment Method	Retention (lbs./ft.3)	BOARDS Retention (lbs./ft.^{3})
Creosote Solution	8.00	8.0
Copper Naphthenate	0.055	0.055
Pentachlorophenol	0.40	0.40
Ammoniacal Copper Arsenate (ACA)	0.40	0.25
Chromated Copper Arsenate (CCA), Type A, B, or C	0.40	0.25
Micronized Copper Azole (MCA)	0.15	0.06
Micronized Copper Quaternary (MCQ)	0.34	0.15
Alkaline Copper Quaternary (ACQ or AC2)	0.40	0.20

Wood boards shall be well seasoned or kiln-dried to minimize warping.

B. Composite Wood

All composite wood products shall have a manufacturer's warranty for the intended use and life of the fence providing coverage against checking, splitting, splintering, rotting, structural damage from termites, and fungal decay of composite wood.

3. INSTALLATION

A. Posts

Posts shall be spaced to accommodate board lengths. Post spacing for wood fence shall not exceed 8 feet on center. Post spacing, size, and installation for composite wood fences shall meet manufacturer's recommendations for the intended use, and size and number of boards.

Wood posts will have a minimum top diameter of 6 inches for large livestock applications and 4 inches for small livestock. Angular wood posts shall have a minimum top, nominal dimension of 6 inches by 6 inches for large livestock applications and 4 inches by 4 inches for small livestock. Wood line posts will be set or driven a minimum of 36 inches. Gate and corner wood posts will be firmly set or driven in the ground a minimum of 48 inches. Wood posts will be of sufficient length to support the height of the fence and be firmly set or driven in the ground.

B. Boards

Boards for wood fence used for small animals and low pressure areas for large animals shall be a minimum size of 1 inch by 6 inches (nominal). Wood boards used for large animal confinement shall be a minimum size of 2 inches by 6 inches (nominal). Boards for wood fence shall be a minimum of 8 feet in length.

Board size for composite wood fence shall be in accordance with manufacturer's recommendations for the intended use of the fence.

Board length should be twice the post spacing with staggered seams on the posts. The boards shall be placed on the livestock side in corrals and other high pressure areas.

Each wood board shall be attached to each post with a minimum of two 16d hot dipped galvanized steel, stainless steel, copper, silicon bronze, or equivalent proprietary coated nails. For better holding power, use ring-shank, spiral, or screw-shank instead of common nails. Two 3-inch decking screws with like treatments may be used instead of nails. Increase the number of nails or screws by one additional nail or screw per 2 linear inches of board nominal width for board nominal widths exceeding 6 inches.

Each composite wood board shall be attached to each post in accordance with manufacturer's recommendations.

WISCONSIN CONSTRUCTION SPECIFICATION

13. GEOTEXTILES

1. SCOPE

This work shall consist of furnishing all materials, equipment, and labor necessary for the installation of geotextiles.

2. MATERIALS

The class and type of geotextile shall be as shown on the drawings.

Geotextiles shall be manufactured from synthetic long chain or continuous polymeric filaments or yarns composed of at least 95 percent by weight of polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride. Fibers shall contain stabilizers and/or inhibitors to enhance its resistance to ultraviolet light. The geotextile shall be formed into a stable network of filaments or yarns that retain dimensional stability relative to each other, including selvages. The geotextile shall be free of any chemical treatment or coating that might significantly reduce its permeability and shall have no flaws or defects that significantly alter its physical properties.

Thread used for factory or field sewing shall be of a contrasting color to the fabric and made of polypropylene, polyester, or polyamide thread. The sewing thread shall have a minimum breaking strength of 28 pounds when tested in accordance to ASTM D 2256. The thread shall be as resistant to ultraviolet light as the geotextile being sewn.

Additional requirements for geotextile materials are as follows:

a. Slit Tape Geotextile

Slit tape geotextile shall conform to the physical properties listed in Table 1. The slit tape geotextile shall be manufactured from a filament that is woven. The edges of the material shall be selvaged or otherwise finished to prevent the outer filament from unraveling.

b. Woven Geotextile

Woven geotextile shall conform to the physical properties listed in TABLE 1. The woven geotextile shall be manufactured from monofilament yarn that is woven into a uniform pattern with distinct and measurable openings. The fabric shall be manufactured so that the yarns will retain their relative position with regard to each other. The edges of the material shall be selvaged or otherwise finished to prevent the outer yarn from unraveling.

c. Nonwoven Geotextile

Nonwoven geotextile shall conform to the physical properties listed in TABLE 2. Nonwoven geotextile shall be manufactured from randomly oriented fibers that have been bonded together by needle-punching.

3. SHIPPING AND STORAGE

Geotextiles labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight, and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

Prior to use, the geotextile shall be inspected and approved by the Technician, then stored in a clean, dry, place, out of direct sunlight, not subject to temperature extremes, and with the manufacturer's protective cover in place.

4. SURFACE PREPARATION

The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. The surface shall be reasonably smooth and free of holes, vegetation, excessive mud, and projections. The surface preparation will be inspected and approved by the Technician prior to placing the geotextile.

5. PLACEMENT

a. General

The geotextile shall be placed on the approved, prepared surface at the locations and in accordance with the details shown on the drawings. The geotextile shall be unrolled along the placement area and loosely laid (not stretched) in such a manner that it will conform to the surface irregularities when the stone or other material is placed on or against it. The geotextile may be folded and overlapped to permit proper placement in the designated area.

No cuts, punctures, tears, or gaps in sewn or overlapped joints will be permitted in the geotextile.

The panel length shall be placed parallel to the direction of water flow, except as stated below in paragraph b. Slope Protection and d. Road Stabilization.

The geotextile panels may be joined by overlapping the roll ends 36 inches and sides a minimum of 18 inches and securing the overlap against the underlying foundation materials. The fabric shall be restrained as needed to prevent lifting and displacement during construction. Allowable restrainment methods include backfilled trenches, stitching, sandbags, rocks, and securing pins that are approved and provided by the geotextile manufacturer. The upstream or up-slope geotextile shall overlap the abutting down-slope geotextile.

The geotextile panels may be joined by machine sewing using thread described under 2. Materials. The seam shall conform to Federal Standard SSa-2, SSn-2 or SSd-2.The sewing shall consist of two parallel stitched rows spaced approximately 1 inch apart. Each row of stitching shall be located a minimum of 2 inches from the geotextile edge. The seam type and sewing machine to be used shall produce a seam strength, in the specified geotextile, that provides a minimum of 90 percent of the tensile strength in the weakest principal direction of the geotextile being used, when tested in accordance with ASTM D 4884. The seams may be

factory or field sewn. All seaming and stitching of woven geotextiles shall be in the selvage. Non-woven geotextiles shall be sewn a minimum of ½ inch from the edge. Geotextile shall be installed with the sewn seams pointing up.

The geotextile shall be restrained as needed during placement of overlying materials to prevent slippage, folding, or other movements of the geotextile.

Prior to covering, the geotextile shall be inspected by the Technician to ensure that the geotextile has not been damaged during construction. Backfill shall be placed by end dumping onto the geotextile from the edge of the geotextile or over previously placed backfill. Vehicles shall not be allowed directly on the geotextile. Materials shall be placed on the geotextile without causing tears, punctures, or separations of overlaps or sewn joints. Should such damage occur, the backfill around the damaged or displaced area will be removed and the subgrade restored to the original approved condition. Repair of the area shall consist of a patch of the same type of geotextile overlaying the existing geotextile. The patch shall extend a minimum of 2 feet from the edge of any damaged area.

b. Slope Protection

The geotextile shall not be placed until it can be anchored and protected with the intended covering within 48 hours. Temporary cover, for protection from ultraviolet light, may be used if the 48-hour limit will be exceeded. Material will not be dropped from a height of more than 3 feet on to uncovered geotextile. In lakeshore applications, the geotextile may be unrolled parallel or perpendicular to the bank. The geotextile shall be joined by machine sewing if the panel length is placed perpendicular to the direction of water flow (wave runup).

c. Subsurface Drains

The geotextile shall not be placed until drainfill or other material can be used to cover it within the same working day. Material will not be dropped from a height of more than 5 feet on to the geotextile and sharp, angular aggregates will not be used unless the drawing details state otherwise.

d. Road Stabilization

The geotextile shall be unrolled in a direction parallel to the roadway centerline in a loose manner permitting it to conform to surface irregularities when the roadway fill material is placed on it. Overlap shall be in the direction of construction. The minimum overlap of geotextile panels joined without sewing shall be 24 inches. The geotextile may be temporarily secured with pins recommended by the manufacturer. They shall be removed prior to placement of the covering material. Slit tape geotextile shall not be used in a wet location. Material will not be dropped from a height of more than 5 feet on to uncovered geotextile.

Table 1. Requirements for Woven Geotextiles by Use

Property	Test Method	Slope Protection		Road Stabilization	
		Unprotected (Class I)	Protected (Class II)	(Class IV)	Slit Tape
Tensile Strength (lbs.)[1]	ASTM D 4632 Grab Test	≥ 250 in any principal direction	≥ 120 in any principal direction	≥ 180 in any principal direction	≥ 200 in any principal direction
Elongation at failure (Percent)[1]	ASTM D 4632 Grab Test	≤ 20	≤ 35	≤ 35	≤ 10
Puncture (lbs.) [1]	ASTM D 6241	≥ 900	≥ 350	≥ 350	≥ 700
Ultraviolet Light (percent residual tensile strength)	ASTM D 4355 150 hours exposure	70 min.	70 min.	70 min.	70 min.
Apparent Opening Size (AOS)	ASTM D 4751	≥ #100 (.150 mm) and ≤ #70 (.212 mm) [3]	≥ #100 (.150 mm) and ≤ #70 (.212 mm) [3]	≥ #100 (.150 mm) and ≤ #70 (.212 mm) [3]	As specified or a min. size > #50 [3]
Percent Open Area (POA)	CW-02215 [2]	4.0 min.	4.0 min.	1.0 min.	N/A
Permittivity (1/seconds) (gal/sq. ft./min.)	ASTM D 4491	0.20 min. 15 min.	0.10 min. 7.5 min.	0.10 min. 7.5 min.	0.05 min. 3.8 min.

[1]Minimum average roll values (MARV); calculated as the mean minus two standard deviations, yielding a 95 percent confidence level that the table value will be equaled or exceeded.

[2]Test Methods prepared by U. S. Army Corps of Engineers

[3]U. S. Standard Sieve Size

Table 2. Requirements for Nonwoven Geotextiles by Use

Property	Test Method	Slope Protection		Subsurface Drainage	Road Stabilization
		Unprotected (Class I)	Protected (Class II)	(Class III)	(Class IV)[3]
Tensile Strength (lbs.) [1]	ASTM D 4632 Grab Test	≥ 180	≥ 120	≥ 90	≥ 180
Elongation At failure(percent)[1]	ASTM D 4632 Grab Test	≥ 50	≥ 50	≥ 50	≥ 50
Puncture(lbs.) [1]	ASTM D 6241	≥ 350	≥ 250	≥ 200	≥ 200
Ultra- Violet Light(percent residual tensile strength)	ASTM D 4355 150 hours exposure	70 min.	70 min.	70 min.	70 min.
Apparent Opening Size (AOS)	ASTM D 4751	As specified or max. #40 [2]	As specified or max. #40 [2]	As specified or max. #40 [2]	As specified or max. #40 [2]
Permittivity (1/seconds)	ASTM D 4491	0.70 min.	0.70 min.	0.70 min.	0.10 min.
(gal/sq. ft./min.)		52.5 min.	52.5 min.	52.5 min.	7.5 min.

[1]minimum average roll values (MARV); calculated as the mean minus two standard deviations, yielding a 95 percent confidence level that the table value will be equaled or exceeded.

[2]U. S. Standard Sieve Size.

[3]Heat-bonded or resin-bonded geotextile may be used.

WISCONSIN CONSTRUCTION SPECIFICATION

14. TIMBER FABRICATION AND INSTALLATION

1. SCOPE

This work shall consist of furnishing all materials, equipment, and the labor necessary for the installation of timber structures and timber portions of composite structures.

2. MATERIALS

Materials for timber and composite structures shall conform to the following requirements:

A. Wood

All wood shall be Grade 2 which has been pressure treated with an oil-base or waterborne preservative listed in Table 1. The following species are applicable to this specification:

Douglas Fir-Larch (North)
Douglas Fir South
Hem-Fir (North)
Red Oak
Ponderosa Pine
Red Pine
Southern Yellow Pine
Western White Pine
White Oak*
White Woods (Western Woods)

White Oak, while not normally treated, is included in this specification as an applicable wood species because of its application in timber construction.

The wood shall be sound, new and free of decay. No pieces of exceptionally light weight shall be accepted.

All lumber and timber dimensions refer to nominal size and the material furnished shall be in American Standard dressed sizes. Posts and planks used in the construction shall be relatively straight throughout their length.

Planks shall have square ends and shall be of uniform width and thickness.

B. Preservatives and Treatment

Unless otherwise specified on the construction plans, all wooden posts and planks, except white oak, shall be treated by a method listed in Table 1. The method used shall meet the applicable American Wood Protection Association (AWPA) Standard or possess an Evaluation Service Report (ESR) recognized by the International Code Council (ICC). A complete list of ICC recognized ESRs can be found at http://www.icc-es.org.

Unless otherwise specified on the construction plans, the minimum retention values shall be as listed in Table 1.

Table 1
Preservative Treatment Retention (lbs/ft^3)

Treatment Method	UC4A Retention (lbs/ft^3) [2]	UC3B Retention (lbs/ft^3)	Applicable Standard or ESR[2]
	Posts & Planks with Ground Contact	Planks with No Ground Contact	
Creosote Solution[1]	10.0	8.0	AWPA P1
Copper Napthenate (CuN)	0.06	0.04	AWPA P9
Pentachlorophenol	0.40	0.30	AWPA P8
Alkaline Copper Quaternary (ACQ), Type B, C, D	0.40	0.15	AWPA P5
Chromated Copper Arsenate (CCA), Type A, B, or C	0.40	0.25	AWPA P5
Copper Azole – Type B (CA-B)	0.21	0.10	AWPA P5
Micronized Copper Azole (MCA)	0.15	0.06	ESR
Micronized Copper Quaternary (MCQ)	0.34	0.15	ESR

[1] Oil-base preservatives containing creosote-petroleum are not recommended with the wood species identified in this specification.

[2] ESR numbers are dependent on supplier and must be listed on the ICC website: http://www.icc-es.org/reports/index.cfm?list=list.

At a minimum, posts and planks for general use with ground contact shall meet AWPA Use Category UC4A*. Planks for exposed, no ground contact applications shall , at a minimum, meet AWPA Use Category UC3B*. Posts and planks for structural building components shall be as specified by the designer.

**AWPA U1-10 Use Category System: User Specification for Treated Wood, May 2010.*

C. Hardware

All fasteners, connectors, and any other metal contacting wood with preservative treatment retentions as listed in Table 1 shall be hot-dip galvanized or stainless steel. **Stainless steel fasteners and connectors shall be used if the wood has preservative treatment retention higher than listed in Table 1.** Galvanizing for fasteners shall conform to ASTM A153. Galvanizing for connectors made from steel sheet shall conform to ASTM A653, Class G185. Galvanizing for all other metal in contact with preservative treated wood shall conform to ASTM A123. Stainless steel shall be AISI Type 304 or 316.

D. Marking

Each treated wood item delivered to the job site shall be identified with a label, brand, or stamp that lists: the product name or logo or treatment company name, name of the preservative, treatment end use category, minimum retention, and the applicable AWPA treatment standard or the number of the ESR. If the label, brand, or stamp is missing, acceptable documentation that the wood item meets the requirements of this specification must be provided to the Technician prior to installation.

3. HANDLING AND STORING WOOD MATERIALS

Lumber stored on the work site shall be close stacked off the ground. The ground beneath the stacked lumber shall be cleared of weeds and rubbish. Materials stacked on the work site for more than seven days shall be protected by a suitable waterproof covering.

4. CONSTRUCTION

Care shall be exercised during installation to avoid damage to the treated surface. All abrasions, saw cuts, and drill holes shall be treated with 3 coats of the same preservative used in the original treatment process, if available, or a wood preservative product that contains a minimum of 2 percent copper metal. The treatment material may be applied by brushing, spraying, or swabbing the entire surface in 3 successive applications.

Posts that have a field-cut and treated end should be installed with the treated end placed into the ground.

Backfill materials placed around the post shall be well consolidated. Sand/gravel backfill shall be compacted in layers not thicker than 4 inches. Concrete backfill shall be placed in layers not thicker than 12 inches before consolidation.

Planks used in wood walls, pumping docks, etc. shall have the end joints staggered except at a point of grade change in any adjacent concrete slab. If the drawings specify that the planks be double thickness, the joints shall not be at the same location. All joints shall be at a post. Nails shall be driven so the heads are flush with the surface of the wood. Deep setting shall be avoided.

Treated wood requires careful handling and disposal. Shirts with long sleeves, full length pants, and waterproof gloves should be worn to minimize skin contact with the wood during handling and installation. A dust mask and eye protection is recommended when sawing treated wood. Dispose of treated wood by ordinary trash collection or burial. The wood shall not be burned in open fires.

WISCONSIN CONSTRUCTION SPECIFICATION

15. Plastic Pipe Conduits

1. SCOPE

The work shall consist of furnishing and installing polyvinyl chloride (PVC), acrylonitrile-butadiene-styrene (ABS), and polyethylene (PE) plastic pipe and the necessary fittings as shown on the drawings. **This specification does not apply to corrugated polyethylene tubing used for subsurface drainage systems.**

2. MATERIALS

Polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

a. D 1785 PVC Plastic Pipe, Schedules 40, 80, and 120.
b. D 2241 PVC Pressure-Rated Pipe (SDR Series).
c. D 2464 Threaded PVC Plastic Pipe Fittings, Schedule 80.
d. D 2466 PVC Plastic Pipe Fittings, Schedule 40.
e. D 2467 Socket-Type PVC Plastic Pipe Fittings, Schedule 80.
f. D 2729 PVC Sewer Pipe and Fittings.
g. D 3034 Type PSM PVC Sewer Pipe and Fittings.
h. F 679 PVC Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
i. F 789 Type PS-46 PVC Plastic Gravity Flow Sewer Pipe and Fittings.
j. F 794 PVC Profile Gravity Sewer Pipe and Fittings, Based on Controlled Inside Diameter.
k. F 949 PVC Corrugated Sewer Pipe with a Smooth Interior and Fittings.

Acrylonitrile-butadiene-styrene (ABS) plastic pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

a. D 1527 ABS Plastic Pipe, Schedules 40 and 80.
b. D 2282 ABS Plastic Pipe (SDR-PR)
c. D 2468 ABS Plastic Pipe Fittings, Schedule 40.
d. D 2469 Socket-Type ABS Plastic Pipe Fittings, Schedule 80.
e. D 2751 ABS Sewer Pipe and Fittings.

Polyethylene (PE) plastic pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

a. D 2104 PE Plastic Pipe, Schedule 40.
b. D 2239 PE Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
c. D 2447 PE Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
d. D 3035 PE Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
e. F 405 Corrugated Polyethylene (PE) Tubing and Fittings.
f. F 667 Large Diameter Corrugated PE Tubing and Fittings.
g. F 714 PE Plastic Pipe (SDR-PR) Based on Outside Diameter.
h. F 2306 PE Plastic Pipe and Fittings - Annular Corrugated Profile Walled - Based on Inside Diameter

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

3. JOINTS AND FITTINGS

Joints and fittings shall be of the same or similar materials as the pipe and equal to or exceeding that specified for the pipe to which it is attached.

Joints may be bell and spigot type with elastomeric gaskets, coupling type with elastomeric gaskets on each end or solvent cemented. The joints shall be installed according to the manufacturer's recommendations unless otherwise specified.

When a lubricant is required to facilitate joint assembly, it shall be a type having no detrimental effect on the gasket or pipe material.

4. HANDLING AND STORAGE

Pipe shall be delivered to the job site and handled by means which provide adequate support to the pipe and does not subject it to undue stresses or damage. When handling and placing plastic pipe, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting. All special handling requirements of the manufacturer shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at temperatures of 40°F or less.

Pipe shall be stored on a relatively flat surface so that the barrels are evenly supported. Unless the pipe is specifically coated to withstand exposure to ultraviolet radiation, it shall be covered with an opaque material when stored outdoors for a period of 15 days or longer.

5. LAYING AND BEDDING THE PIPE

The pipe shall be laid to the lines and grades as shown on the drawings and specified herein. The pipe shall be laid so that there is no reversal of grade between joints, unless otherwise shown on the drawings. The pipe shall not be dropped or dumped on the bedding or into the pipe trench. The ground surface near the pipe trench shall be free of loose rocks and stones greater than 1 inch in diameter. This ensures that rock will not be displaced and impact the pipe.

Just before placement, each pipe section shall be inspected to ensure that all foreign material is removed from inside the pipe. The pipe ends and the couplings shall be free of foreign material when assembled. At the completion of a work shift, all open ends of the pipeline shall be temporarily closed off using a suitable cover or plug.

Care shall be taken to prevent distortion and damage during unusually hot (over 90°F) or cold weather (under 40°F). After the pipe has been assembled in the trench, it shall be allowed to reach ground temperature before backfilling to prevent pull out of joints due to thermal contraction.

Bell and spigot pipe shall be laid with the bell pointed upstream. The pipe ends and couplings shall be free of foreign material when assembled.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid and before the pipe is approved for backfill.

The pipe shall be firmly and uniformly bedded throughout its entire length. The bedding depth and materials to be used will be as shown on the drawings. For pipe with bell joints, the bedding material shall be excavated at the locations of the bells to prevent the pipe from being supported by the bells.

6. PIPE EMBEDMENT

Earth bedding – The pipe shall be firmly and uniformly placed on compacted earthfill bedding or an in-place earth material bedding of ample bearing strength to support the pipe without noticeable settlement. The earth material on which the pipe is placed shall be of uniform density to prevent differential settlement.

Unless otherwise specified, a groove that closely conforms to the outside surface of the pipe shall be formed in the bedding. The depth of the groove shall be equal to or greater than 0.3 of the pipe diameter.

Earth bedding shall be compacted to a density not less than adjacent undisturbed in-place earth material or be compacted earth backfill. Earthfill material used for compacted earth bedding shall be free of rocks or stones greater than 1 inch in diameter and earth clods greater than 2 inches in diameter. The pipe shall be loaded sufficiently during the compaction of bedding under the haunches and around the sides of the pipe to prevent displacement from its final approved placement.

Sand, gravel, or crushed rock bedding – When sand, gravel, or crushed rock bedding is specified, the pipe shall be firmly and uniformly placed on the bedding material. Material for bedding shall not exceed 1 inch in diameter. Unless otherwise shown on the drawings, the coarse-grained bedding material shall be carefully placed and compacted to a depth equal to or greater than 0.3 of the diameter of the pipe above the bottom of the pipe. The pipe shall be loaded sufficiently during backfilling and compaction around the sides to prevent displacement of the pipe from its final approved placement.

Pipe encased in drainfill – The pipe shall be firmly and uniformly placed on bedding of specified drainfill. Drainfill shall be placed and compacted as specified in Wisconsin Construction Specification 8, Drainfill or as shown on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides and during compaction to prevent displacement of the pipe.

Pipe encased in concrete – Concrete encasement shall be carefully placed to form a continuous uniform support around the entire circumference of the pipe or as shown on the drawings. Pipes encased in concrete shall be securely anchored to prevent movement of the pipe during concrete placement. A clear distance of 1.5 inches shall be maintained between the pipe and any reinforcing steel.

7. BACKFILL

Initial backfill – Unless otherwise specified or shown on the drawings, initial backfill to 6 inches above the top of the conduit is required. Earth haunching and initial backfill material shall consist of soil material that is free of rocks, stones, or hard clods more than 1 inch in diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill material.

Initial backfill shall be placed in two stages. In the first stage (haunching), backfill is placed to the pipe spring line (center of pipe). In the second stage, it is placed to 6 inches above the top of the pipe.

The first stage material shall be worked carefully under the haunches of the pipe to provide continuous support throughout the entire pipe length. The haunching backfill material shall be placed in layers that have a maximum thickness of about 6 inches and are compacted as shown on the drawings or as stated in the Wisconsin Construction Specification appropriate for the backfill material. During compaction operations, care shall be taken to ensure that the tamping or vibratory equipment does not come in contact with the pipe and the pipe is not deformed or displaced.

Final backfill – Final backfill shall consist of placing the remaining material required to complete the backfill from the top of the initial backfill to the ground surface, including mounding at the top of the trench. Final backfill material within 2 feet of the top of the pipe shall be free of debris or rocks larger than 3 inches nominal diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill. Final backfill shall be placed in approximately uniform, compacted layers. Final backfill compaction and layer thickness requirements shall be as shown on the drawings or as stated in the Wisconsin Construction Specification appropriate for the backfill material.

WISCONSIN CONSTRUCTION SPECIFICATION

24. Construction Surveys

1. Scope

   The work consists of performing all layout, construction control, and documentation required by the project.

2. Equipment and Material

   Conventional and Global Positioning System (GPS) survey equipment shall be of a quality and condition to provide the required accuracy. The equipment shall be maintained in good working order and in proper adjustment at all times. Equipment shall be checked, tested, and adjusted in conformance with manufacturer's recommendations.

3. Quality of Work

   All work shall follow professional practice and the standards of the industry. The work shall be performed to the tolerances in Table 1. Notes, sketches, and other data shall be complete, legible, reproducible, organized to facilitate review, and allow reproduction of copies for job documentation.

Table 1 - Positional Accuracy and Allowable Tolerances (+/- ft)

	Elevation	Location by Distance[1]	Location by Given Coordinate[2]
Control Points (PT, PC, etc)	0.01	0.1	0.1
Concrete works and pipe inverts	0.01	0.1	0.1
Earth work	0.1	0.3	0.5

[1] Location relative to know baseline station or offset station (profile or cross section)
[2] Location relative to know coordinates (GPS or Total station)

Point Closure Ratio Accuracy

The closure error on a benchmark shall be 1:2,500 horizontally and 0.10 * $\sqrt{M}$ vertically.

The horizontal point closure is determined by dividing the linear distance misclosure of the survey by the overall circuit length of a traverse, loop, or network line/circuit (Sum of FS and BS distance). In cases where GPS vectors are measured in geocentric coordinates, the three-dimensional positional misclosure is assessed.

The vertical accuracy of a survey is determined by the elevation misclosure (feet) within a level section or level loop, where the line or circuit length (M) is measured in miles. (M = sum of FS and BS distance in miles)

4. Primary Control

   Primary controls, which include items such as baselines, control points, and bench marks, necessary to establish lines, grades, and locations are shown on the drawings and have been established on the job site.

   These baselines, control points, bench marks, and GPS coordinates shall be used as the origin of all surveys, layouts, and measurements to establish construction lines, grades, and locations. The Contractor shall take precautions to prevent the loss or damage of primary control points. Stakes or control points lost or damaged by construction activity will be reestablished by the Contractor or at the Contractor expense.

5. Construction Surveys

   Electronic GPS coordinates and elevation files, used as primary control and for design, will be provided to the Contractor. No work shall take place without approval of field layout by the Technician.

   The Contractor is responsible for the following items by use of conventional or GPS survey equipment.

   a. Establishing centerline for location and alignment.
   b. Establishing location and elevation of additional control points.
   c. Setting slope stakes and reference stakes.
   d. Intermittent checking and any supplemental or interim staking.
   e. Establishing final grade stakes.
   f. Providing final constructed locations and grades for the work.
   g. Recording survey documentation.

6. Records

   Survey data shall be recorded in fully identified standard hard-bound engineering survey field notebooks with consecutively numbered pages. All field notes and printed data shall include the purpose or description of the work, the date the work was performed, sketches, and the personnel who performed and checked the work.

   Electronically generated survey data shall be cross referenced in the bound field notebook containing the index for all survey activities.

   The construction survey records shall be available at all times during the progress of the work for examination and use by the Technician and when requested, copies shall be made available.

   The original field notebooks and other records shall be provided to the Government for acceptance of all work. The records will become the property of the owner.

7. Acceptance

   The job will not be accepted until all surveys are complete and required documentation has been determined complete. The Technician shall conduct quality assurance checking. Checking shall include the visual review of survey markings, notes, and random surveys to check for accuracy.

WISCONSIN CONSTRUCTION SPECIFICATION

26. Topsoiling

1. SCOPE

The work consists of furnishing and spreading topsoil to specified depths at locations shown on the drawings. This specification does not apply to any other earthfill.

2. MATERIALS

Topsoil shall consist of naturally occurring friable surface soil reasonably free of grass, roots, weeds, sticks, rocks, other unsuitable material, herbicides, or other compounds whose presence would prevent establishment of grass and/or legume sod cover.

Topsoil shall be obtained from soil surfaces containing USDA soil textural classifications of loam, sandy loam, silt loam, silty clay loam, sandy clay loam, or clay loam soils shown on the drawings or acceptable to the Technician.

Topsoil shall:

- be salvaged from designated areas that will be disturbed by construction activities or be furnished from an offsite source designated by the Contractor. The Technician shall be granted access to the source for inspection and acceptance before delivery to the site.
- meet the following requirements (when testing is required):
  - 100% passing the ¾-inch sieve.
  - minimum 95% passing the #10 sieve.
  - minimum 25% passing the #200 sieve.
  - 3% - 15% organic material.
  - non-positive herbicide carryover (UW Extension Publication A3819, Herbicide Persistence and Carryover).

3. TESTING

The Technician will determine the need for testing the topsoil for gradation, percent organic matter content, and herbicide carryover effect. The testing will be at the expense of the Contractor.

4. FOUNDATION PREPARATION AND PLACEMENT

The surfaces designated to receive a topsoil application shall be cleared of all objectionable materials including trees, stumps, roots, brush, rubbish, and stones having a maximum dimension greater than 6 inches. The surfaces shall be lightly scarified just before the spreading operation. Topsoil shall not be placed until the required excavation, fill and preparation of the surfaces is complete and approved by the Technician.

Spreading shall not be conducted when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to uniform spreading operations. Snow, ice, or frozen material shall not be incorporated in the topsoil.

Topsoil shall be placed in approximately horizontal layers no greater than 8 inches thick.

Placement of topsoil adjacent to concrete structures may begin after the concrete has cured for the minimum time specified. Heavy equipment shall not be operated within 2 feet of any structure.

Following the spreading operation, the topsoil surface shall be left reasonably smooth and without ruts or surface irregularities that could contribute to concentrated waterflow downslope.

5. MOISTURE CONTENT

Topsoil shall have a moisture content sufficient to insure the spreading of the material to the required thickness. When kneaded in the hand the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

6. COMPACTION

The Contractor shall furnish and operate the types and kinds of equipment necessary to compact the topsoil material when specified. The Technician shall determine if adequate compaction is being achieved.

Adequate compaction is defined as a firm surface able to support the growth of vegetation. Methods for compaction may include back-blading or a single pass from a rubber tire, track, or roller. A pass shall consist of complete coverage by the rubber tire, track, or roller over the entire surface of the topsoil. Care must be taken to avoid excessive compaction of topsoil.

Adjacent to structures or in confined areas, compaction of topsoil shall be accomplished by means of manually directed power tampers of plate vibrators or hand tamping, unless otherwise specified.

Where compacted earthfill is designated to be topsoiled, the topsoil shall be placed concurrently with the earthfill and shall be bonded to the compacted fill with the compacting equipment.

WISCONSIN CONSTRUCTION SPECIFICATION

44. CORRUGATED POLYETHYLENE TUBING

1. SCOPE

The work shall consist of furnishing and installing corrugated polyethylene tubing with the necessary fittings and appurtenances as shown on the drawings and as outlined in this specification.

2. MATERIALS

Corrugated polyethylene tubing and fittings shall conform to the material requirements for the appropriate tubing size as shown in the following specifications:

- ASTM F 405: 3 to 6 inch diameter pipe
- ASTM F 667: 8, 10, 12, 15, 18, and 24 inch diameter pipe
- ASTM F 894: 18 to 120 inch diameter profile wall pipe
- AASHTO M 252: 3 to 10 inch diameter
- AASHTO M 294: 12 to 36 inch diameter

The tubing shall be appropriately marked with the ASTM or AASHTO designation.

When perforations are specified, the water inlet area shall be a minimum of 1 square inch per lineal foot of tubing. The inlets shall either be circular perforations or slots equally spaced along the length and circumference of the tubing. Unless otherwise specified, circular perforations shall not exceed 3/16 inch in diameter, and slot perforations shall not be more than 1/8 inch wide.

Geotextile filter socks, when required, shall meet the material requirements specified by the manufacturer for the intended use of the tubing.

Granular bedding material, when specified, shall conform to the requirements specified on the drawings.

3. HANDLING AND STORAGE

Tubing shall be delivered to the job site and handled by means that provide adequate support to the tubing and do not subject it to undue stresses or damage. When handling and placing corrugated polyethylene tubing, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting (by metal edges and/or surface or rocks). The manufacturer's special handling requirements shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at a temperature of 40 degrees Fahrenheit or less.

4. EXCAVATION

Unless otherwise specified or approved, excavation for and subsequent installation of each tubing line shall begin at the outlet end and progress upgrade. The trench or excavation for the tubing shall be constructed to the lines, depths, cross sections, and grade shown on the drawings.

Trench shields, shoring and bracing, or other suitable methods necessary to safeguard the workers shall be furnished, placed, and subsequently removed by the contractor.

5. BEDDING THE TUBING

Tubing shall not be laid on a rock foundation. In the event that boulders, rock or ledge rock, or other cemented materials that prevent satisfactory bedding are encountered at the required grade, the trench shall be excavated to a depth of at least 6 inches below the grade and backfilled to the required grade with a sand-gravel mixture or other approved material.

If the bottom of the trench does not provide a sufficiently stable or firm foundation for the tubing, a sand-gravel mixture or other approved materials shall be used to stabilize the bottom of the trench.

When a granular filter or envelope is specified, the filter or envelope material shall be placed in the bottom of the trench just before the tubing is laid. The tubing shall then be laid and the filter and envelope material placed to a depth over the top of the tubing of not less than that shown on the drawings.

When a granular filter or envelope is not specified, the bottom of the earthen trench shall be shaped to form a semicircular, trapezoidal, or 90-degree "V" groove in its center. This groove shall provide support for not less than a fourth of the outside circumference of the tubing. After the tubing is placed in the excavated groove, it shall be capped with friable material from the sides of the trench. The friable material shall be placed around the tubing, completely filling the trench to a depth of at least 3 inches over the top of the tubing. For material to be suitable, it must not contain hard clods, rocks, frozen soil, or fine material that will cause a silting hazard to the drain. Tubing placed during any day shall be blinded (place required soil material around and over pipe) and temporarily capped before construction activities are completed for that day.

6. PLACEMENT AND JOINT CONNECTIONS

All tubing shall be installed to the grade shown on the drawings. After the tubing is placed in the trench and blinded, sufficient time shall be allowed for the tubing to adapt to the soil temperature before backfilling.

Maximum allowable stretch of the tubing is 5 percent. Special precautions must be implemented on hot, bright days to ensure that the stretch limit is not exceeded and excessive deflection does not occur as a result of installation procedures, including backfill operations.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the tubing is laid.

Lateral connections shall be made with manufactured junctions comparable in strength with the specified tubing.

The pipe ends and the couplings shall be free of foreign material when assembled. During the placement of the tubing, each open end shall be closed off with a suitable cover or plug at the end of the workday until work resumes.

All split fittings shall be securely fastened with nylon cord or plastic zip ties before any backfill is placed.

All buried ends of the tubing shall be supplied with end caps unless otherwise shown on the drawings.

7. BACKFILLING

The backfilling of the trench shall be as shown on the drawings and completed as rapidly as is consistent with the soil conditions. Automatic backfilling machines may be used. Backfill shall be placed so that displacement or deflection of the tubing will not occur. Backfill shall extend above the ground surface to allow for settlement and be well rounded and centered over the trench.

WISCONSIN CONSTRUCTION SPECIFICATION

202. Polyethylene Geomembrane Lining

1. SCOPE

The work shall consist of furnishing, transporting, and placing a high density polyethylene (HDPE) or linear low density polyethylene (LLDPE) geomembrane liner to the elevations, grades and cross sections as shown on the drawings or as staked in the field.

2. MATERIALS

The geomembrane liner shall have a nominal thickness as specified on the drawings and be specifically manufactured to be suitable for use in exposed and buried conditions. The liner shall conform to the material properties in Table 1 through Table 4 as applicable.

3. SHIPPING AND STORAGE

The geomembrane liner shall be shipped to the job site in a manner not to damage the rolls. The liner rolls shall be stored so they are protected from puncture, dirt, grease, water, moisture, mechanical abrasion, excessive heat, or other damage. The rolls shall be stored on a smooth surface (not wooden pallets) and not stacked more than two rolls high.

All geomembrane shall be free of damage or defect. Damaged liner material shall be repaired or replaced. Each package delivered to the job site shall bear the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material.

4. SUBGRADE PREPARATION

The area to be lined shall be drained and allowed to dry until the surface is firm. The surface must support people and equipment that must travel over it during installation of the geomembrane liner. All cut and fill slopes shall be constructed in accordance with the drawings. Required subgrade fill shall be placed in accordance with Wisconsin Construction Specification 204, Earthfill For Waste Storage Facilities.

The foundation area shall be smooth and free of projections that can damage the geomembrane. Stumps and roots shall be removed. Rocks (larger than 3/8" and all fractured rocks), hard clods, and other such material shall be removed, rolled with a smooth-wheeled vibratory roller, or covered with a compacted cushion of fine soil. A non-woven geotextile cushion may be used in ponds that are not a component of a waste management system. Surface deformations from equipment tracks or footprint indentations shall not exceed 1 inch. Standing water, mud, and snow shall be removed prior to liner placement.

An anchor trench for the liner shall be excavated and backfilled in accordance with the drawings. The trench corners shall be slightly rounded to prevent sharp bends in the liner.

5. PLACEMENT

The placement of the geomembrane liner shall be performed by an experienced Contractor. The installation shall comply with the manufacturer’s procedures and specifications. Continuous inspection shall be provided by an experienced third party (not an employee of the Contractor or membrane suppliers) for all deployment, seaming, seam testing, and concrete placement.

The geomembrane liner rolls shall be deployed using a spreader bar assembly attached to a loader bucket or by other methods approved by the liner manufacturer. The method chosen to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil or any underlying geotextile. The liner rolls shall not be deployed by allowing the roll to run freely down the slope.

The liner shall not be placed in the presence of excessive winds, during foggy conditions, or precipitation events. The liner shall not be placed when the temperature is less than 50 degrees Fahrenheit unless approved by the manufacturer.

The liner shall be loosely spread over the foundation with sufficient slack to accommodate thermal expansion and contraction expected during construction. Sufficient slack shall be provided near all points of solid anchorage (welds to embedment strips fixed in concrete and pipe penetrations, etc.) to accommodate thermal expansion and contraction expected prior to final acceptance of the work. Any damage due to inadequate slack in the liner shall be the responsibility of the geomembrane installer and shall be repaired.

Each panel shall be laid out and positioned to keep the number and length of the geomembrane field joints to a minimum and consistent with proper methods of geomembrane installation. The method used to place the panels shall minimize wrinkles especially along field seams. Wrinkles shall not exceed 6 inches in height or “fold over.”

Seams shall be oriented down, not across the slope. No horizontal seams are allowed on the side slopes or within 5 feet of the toe or crest of a side slope. Sharp corners shall be avoided. On the floor of a facility, up slope panel overlaps shall shingle down slope. Horizontal and T-shaped seams shall not be placed on slopes. All T-seams or seams where three or more panels come together shall include a minimum 24-inch diameter extrusion welded patch centered over the seam intersection and installed in accordance with this specification. No base T-shaped seam shall be closer than 5 feet to the toe of the side slope. Seams shall be aligned with the least possible number of wrinkles or "fishmouths." All fishmouths shall be cut out and the area repaired by patching.

Adequate loading (e.g., sand bags or similar items that will not damage the liner) shall be placed to prevent relocation of the compensating wrinkles or uplift of the liner by wind.

The top edge of the liner shall be placed in the anchor trench and anchored with compacted backfill. Compact the backfill by wheel rolling with light rubber-tired equipment or a manually directed power tamper.

Construction equipment contact shall not be allowed to operate directly on the liner. Portable generators may be positioned on the lined area provided that the liner is protected by an adequate cushion of geotextile or an additional layer of liner material. The installer shall not refuel generators or other equipment that uses petroleum products while the equipment is located on the liner. Equipment shall be maintained such that no petroleum products come into contact with the liner.

No equipment or tools shall damage the liner by handling, traffic, or by other means. Personnel working on the liner shall not smoke, wear damaging shoes, or engage in other activities that could damage the liner. Use of metal tools shall be kept to a minimum.

6. SEAMING

SEAMING SHALL NOT BE ALLOWED DURING PRECIPITATION EVENTS.

PARALLEL WELDS MUST BE SEPARATED BY A DISTANCE OF AT LEAST 6".

All areas that are to become seam interfaces will be cleansed of dust and dirt. Seaming shall not take place unless the geomembrane material is dry. Seaming shall not be attempted when the ambient sheet temperature is below 45° F or above 90° F unless it can be demonstrated that competent welds can be achieved down to 32° F or up to 125° F sheet temperature.

A. Hot-Wedge Seams

Field seams shall be made by overlapping adjacent liner panels a minimum of 4 inches and fusion welding the overlapped sheets using double-wedge fusion welders. Seams between panels shall be field welded using the installer's seaming apparatus and technique.

B. Fillet Extrusion Seams

Extrusion welding shall be used only at areas which cannot be welded by using the double-wedge fusion welder (i.e., repairs, T-seams, etc.). For extrusion welds, the liner shall be abraded by light grinding, preheated and pressed together to align for welding. Minimum overlap of liner panels shall be 3 inches.

7. SEAM TESTING

A. Trial Weld Seam Testing

Seam tests shall be conducted under field conditions by the installer at the beginning of each seaming period, once in the morning and once in the afternoon. Trial welds shall be completed using scraps of material from the liner installation. Six specimens from each trial weld shall be cut from the trial weld and tested in the field by a tensiometer in shear and peel modes. Four specimens shall be tested in peel and two specimens shall be tested in shear. The installer shall supply calibration certification for the field tensiometer. Test seams shall meet the material properties in Table 1 through Table 4 as applicable. Each specimen shall be 1 inch wide and be tested at a grip separation rate of 2 inches per minute. All peel tests shall result in Film Tear Bond (FTB) failure. Both the inside and outside track of double fusion welds shall be tested.

B. Non-Destructive Seam Testing

The installer shall non-destructively test all field seams over their full lengths. Seam testing shall be performed as the work progresses.

1) Air Pressure Tests shall be performed in accordance with ASTM D 5820 on all double-wedge fusion seams. The air pressure test equipment and procedures shall conform to this specification and the liner manufacturer's specification. The air channel shall be pressurized to 25-30 psi and monitored for any pressure loss for 5 minutes. A loss of pressure in excess of 4 psi or a continuous loss of pressure is an indication of a leak. Terminate the test by relieving the pressure from the end of the seam opposite from the end of the seam that pressure was applied. The pressure shall immediately drop to zero upon opening the opposing end of the seam. If not, the seam channel shall be checked for obstructions and re-tested. All defects shall be marked for repair. All areas with failing air pressure tests shall be repaired by capping. All repaired failing seam areas shall be bounded by passing tests.

2) Vacuum Box Tests shall be performed in accordance with ASTM D 5641 on all extrusion welds. The vacuum box equipment and procedures shall conform to this specification and the liner manufacturer's specification. Apply soapy water solution to the seam area to be tested. The vacuum box, equipped with a transparent viewing window, shall be centered over the seam area and a vacuum of 3-5 psi shall be drawn. The seam area shall be visually monitored for any soap bubbles for 15 seconds. Seam testing shall continue by overlapping a minimum of 3 inches between each test interval. All defects shall be marked for repair. All repaired failing seam areas shall be bounded by passing tests.

C. Destructive Seam Testing

Samples for destructive seam testing in a laboratory shall be cut at no more than one sample per 500 feet of seam per welder and operator combination. The location of the samples shall be marked in the field by the Technician or third party quality assurance professional. The samples shall be a minimum of 36 inches long and shall be cut from the liner by the geomembrane installer. Destructive samples shall be divided into two portions with one being tested in the field and one sent to an independent testing laboratory for verification. A minimum of three coupons for shear and three for peel shall be tested in the field. Both the inside and outside track of double fusion welds shall be tested in peel. If the coupons tested in the field meet applicable seam property requirements in Tables 1 through 4, the Contractor shall forward the remaining laboratory portion of the sample to the laboratory for testing. The Contractor shall provide copies of the laboratory testing results to the owner and to the third party inspector or Technician. If the field coupons do not meet project requirements, the laboratory portion of the sample shall be discarded and the seam shall be repaired in accordance with Section 9. Likewise, if the laboratory test results demonstrate that the seam does not meet project requirements, the seam shall be repaired in accordance with Section 9. Repair holes in the liner resulting from destructive seam sampling immediately and vacuum test in accordance with procedures described in this specification.

8. APPURTENANCES

A. Gas Vents or Vent Pipes shall be installed in accordance with the drawings to provide gas release for the liner system.

B. Pipe Boots for all pipes shall be fabricated in the field from the same liner as shown on the drawings. Pipe boots shall be clamped to the pipe as shown on the drawings to provide a leak-free attachment.

C. Egress Strips shall be installed at the locations shown on the drawings.

9. REPAIRS

All defective liner areas and seams shall be repaired and non-destructively tested prior to completion of the installation.

A. Tears, Punctures, Material Defects

All tears, punctures, or material defects in the liner shall be repaired by installation of a patch over the defective area. Surfaces of the liner to be patched shall be cleaned no more than 15 minutes prior to the repair. All patches shall be made of the same liner material and extend a minimum of 6 inches beyond the edges of the defect area. Patches shall have rounded corners and shall be seamed to the liner. Small holes less than 1/4 inch in diameter shall be repaired by applying a bead of welding extrudent.

B. Seam Repair

All failed seams shall be repaired by installing a cap strip over the entire length of the failed seam. The cap strip shall be of the same liner material and shall extend beyond the failed seam a minimum of 6 inches in all directions.

10. PLACEMENT OF CONCRETE OR GROUT PILLOWS

Placement of concrete pads and ramps shall be in accordance with the drawings and shall conform to Wisconsin Construction Specification 4.

A. Concrete Joined to the Geomembrane

CONCRETE PADS, RAMPS AND APPURTENANCES SHALL BE CONSTRUCTED PRIOR TO PLACING THE GEOMEMBRANE LINER.

Concrete ramps, pads, and appurtenances shall have approved premanufactured geomembrane embedment strips cast into the concrete per the manufacturer's specifications. The concrete Contractor shall obtain the embedment strips from the liner installer along with the manufacturer's installation instructions. The embedment strips shall be stored at locations where excessive heat or sunlight will not cause deformation of the strip. The embedment strips shall be fully embedded into the concrete with no gaps between the strips. Joints between the strips shall be extrusion welded or an approved expanding sealant material placed under the joint.

Stainless steel batten strips shall be installed as shown on the drawings.

B. Concrete or Grout Pillows Placed Over the Geomembrane

Concrete or grout pillow pads, ramps, and appurtenances shall be constructed in a manner that does not puncture the geomembrane and does not jeopardize the integrity or performance of the geomembrane liner in any way.

The Contractor shall submit shop drawings, which include all details necessary to ensure compliance with this specification, to the Engineer at least five business days prior to the anticipated date of concrete construction. Concrete or grout pillow construction shall not occur until the Contractor obtains written approval of the shop drawings from the Engineer.

11. CONSTRUCTION QUALITY ASSURANCE

A quality assurance plan for the installation of the geomembrane and all appurtenances shall be submitted to the Engineer for approval at least five business days prior to installation.

All geomembrane placement, seaming, seam testing, and repair, as well as concrete construction shall be completed under the continuous observation of a qualified independent third party quality assurance inspector under the direction of a Professional Engineer registered in Wisconsin. The quality assurance inspector shall not be an employee of the Contractor, owner, or geomembrane supplier.

A construction quality assurance report shall be prepared and submitted to the owner, cost sharing agency, and/or permitting agencies as appropriate. The report shall include, at a minimum:

- A panel layout diagram showing the location of panels and the seam numbering system used.

- Documentation that the entire length of all seams has been non-destructively tested by air channel tests or vacuum box tests as applicable.

- Documentation that all seams that did not initially pass the non-destructive test have been repaired and that the repair has passed a non-destructive test.

- Documentation that the destructive seam samples have been taken at the required frequency, have been tested in an off-site laboratory, and have met the project requirements.

- Documentation that seams have been repaired where laboratory destructive seam sample testing has indicated that seams did not initially meet project requirements.

- Documentation that the entire surface of the liner has been observed and that all blemishes, punctures, fishmouths, and other irregularities that could jeopardize the performance of the liner have been acceptably repaired.

12. BASIS OF ACCEPTANCE

The acceptability of the geomembrane liner shall be determined by inspections to check compliance with all the provisions of this specification, with respect to the drawings, markings, the appurtenances, and the minimum installation requirements.

The installer shall certify that the installation complies with the requirements of this specification. A written guarantee shall be furnished that protects the owner against defective workmanship for a minimum of two years.

TABLE 1

Requirements for Smooth HDPE Geomembrane Liner

Nominal Thickness: 40 mil and 60

Property	Test Method	Minimum Average Roll Values[1]	
		40 mil	60 mil
Density, g/cc	ASTM D 1505	0.940	0.940
Tensile Properties yield stress, lb/in	ASTM D 6693 (Type IV at 2 in/min)	84	126
break stress, lb/in		152	228
yield elongation, %		12	12
break elongation, %		700	700
Tear Resistance, lb.	ASTM D 1004	28	42
Puncture Resistance, lb.	ASTM D 4833	72	108
Carbon Black Content, %	ASTM D 1603	2-3	2-3
Carbon Black Dispersion	ASTM D 5596	Category 1 or 2	
Seam Properties shear strength, lb/in	ASTM D 6392	80	120
peel strength, lb/in		52/FTB[2]	78/FTB[2]

[1] All values, unless otherwise specified, are minimum average roll values as reported for the test method.

[2] Film Tear Bond: A failure of one of the bonded sheets by tearing prior to complete separating in the bonded area.

TABLE 2

Requirements for Textured HDPE Geomembrane Liner

Nominal Thickness: 40 mil and 60 mil

Property	Test Method	Minimum Average Roll Values[1]	
		40 mil	60 mil
Density, g/cc	ASTM D 1505	0.940	0.940
Tensile Properties yield stress, lb/in	ASTM D 6693 (Type IV at 2 in/min)	84	126
break stress, lb/in		60	90
yield elongation, %		12	12
break elongation, %		100	100
Tear Resistance, lb.	ASTM D 1004	28	42
Puncture Resistance, lb.	ASTM D 4833	60	90
Carbon Black Content, %	ASTM D 1603	2-3	2-3
Carbon Black Dispersion	ASTM D 5596	Category 1 or 2	
Seam Properties shear strength, lb/in	ASTM D 6392	80	120
peel strength, lb/in		52/FTB[2]	78/FTB[2]

[1] All values, unless otherwise specified, are minimum average roll values as reported for the test method.

[2] Film Tear Bond: A failure of one of the bonded sheets by tearing prior to complete separating in the bonded area.

TABLE 3

Requirements for Smooth LLDPE Geomembrane Liner

Nominal Thickness: 40 mil and 60 mil

Property	Test Method	Minimum Average Roll Values[1]	
		40 mil	60 mil
Density, g/cc	ASTM D 1505	0.915	0.915
Tensile Properties break stress, lb/in	ASTM D 6693 (Type IV at 2 in/min)	150	228
break elongation, %		800	800
Tear Resistance, lb.	ASTM D 1004	22	33
Puncture Resistance, lb.	ASTM D 4833	56	84
Carbon Black Content, %	ASTM D 1603	2-3	2-3
Carbon Black Dispersion, %	ASTM D 5596	Category 1 or 2	
Seam Properties shear strength, lb/in	ASTM D 6392	58	90
peel strength, lb/in		50/FTB[2]	75/FTB[2]

[1] All values, unless otherwise specified, are minimum average roll values as reported for the test method.

[2] Film Tear Bond: A failure of one of the bonded sheets by tearing prior to complete separating in the bonded area.

TABLE 4

Requirements for Textured LLDPE Geomembrane Liner

Nominal Thickness: 40 mil and 60 mil

Property	Test Method	Minimum Average Roll Values[1]	
		40 mil	60 mil
Density, g/cc	ASTM D 1505	0.915	0.915
Tensile Properties break stress, lb/in	ASTM D 6693 (Type IV at 2 in/min)	80	120
break elongation, %		350	350
Tear Resistance, lb.	ASTM D 1004	22	33
Puncture Resistance, lb.	ASTM D 4833	44	66
Carbon Black Content, %	ASTM D 1603	2-3	2-3
Carbon Black Dispersion, %	ASTM D 5596	Category 1 or 2	
Seam Properties shear strength, lb/in	ASTM D 4437	53	79
peel strength, lb/in		50/FTB[2]	75/FTB[2]

[1] All values, unless otherwise specified, are minimum average roll values as reported for the test method.

[2] Film Tear Bond: A failure of one of the bonded sheets by tearing prior to complete separating in the bonded area.

WISCONSIN CONSTRUCTION SPECIFICATION

204. EARTHFILL FOR WASTE STORAGE FACILITIES

1. SCOPE

The work shall consist of all operations necessary to place the earthfill required by the drawings or directed by the Technician.

2 MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the Technician.

Fill materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Stones larger than two-thirds of the uncompacted layer thickness shall be removed from the materials prior to compaction of the fill.

3. GENERAL

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized. The completed job shall present a professional appearance and shall conform to the lines, grades, and elevations as shown on the drawings or as staked in the field. All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

4. FOUNDATION PREPARATION

The foundation area shall be cleared of trees, stumps, roots, brush, rubbish, frozen soil, and stones having a maximum dimension greater than 6 inches. Foundations shall be stripped to remove vegetation and other unsuitable materials to a minimum depth of 6 inches or to a greater depth if so shown on the drawings. Topsoil shall be stripped from the foundation area and stockpiled for use as a top dressing for vegetation establishment unless otherwise shown on the drawings.

The moisture content of the scarified foundation materials shall be maintained as specified for the earthfill in Section 7. The surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

5. EXCAVATION

The required excavations shall conform to the lines, grades, and elevations as shown on the drawings. Excavation beyond specified limits shall be corrected by filling with approved compacted materials.

The required dimensions and side slopes of all structure and trench excavations shall be as shown on the drawings. Trenches deeper than 4 feet shall have side slopes above the 4-foot depth excavated at 0.5:1 or flatter depending on the materials being excavated or the trench shall be braced to safeguard the work and workers. When backfilling pipe trenches in the waste storage facility embankment, the trench slopes shall be cut back to 1:1 from 12 inches above the top of the pipe. The backfill material and compaction shall be equivalent to the surrounding embankment.

To the extent that they are needed, all suitable materials removed from the specified excavations shall be used in the construction of the required earthfill. The suitability of materials for specific purposes will be determined by the Technician.

All surplus or unsuitable excavated materials shall be disposed of at the locations shown on the drawings or as approved by the Technician. Surplus materials shall not be placed in wetlands.

6. BORROW AREAS

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fill portions of the permanent works, additional materials shall be obtained from the designated borrow areas. The borrow area shall be stripped to remove vegetation or other unsuitable materials to a minimum depth of 6 inches or to the depth shown on the drawings. This stripping shall be performed immediately prior to use of the borrow material to reduce the time the area is exposed to erosion. For large borrow areas, only a portion of the area should be stripped at a time.

7. FILL MOISTURE CONTENT

Fill materials shall have a moisture content sufficient to insure the required compaction. When kneaded in the hand, the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

If the top surface of compacted fill is too dry to permit suitable bond, it shall either be removed or scarified and wetted by sprinkling to an acceptable moisture content prior to placement of the next layer of fill. The applied water must be allowed time to be absorbed by the fill or disked into the dry layer.

Fill material that is too wet shall be allowed to dry to an acceptable moisture content before placement. If the top surface of compacted fill is too wet, it shall be either removed or allowed to dry to an acceptable moisture content before compaction or placing additional layers of fill.

8. FILL PLACEMENT

Fill shall not be placed until the required excavation and preparation of the underlying foundation is completed and approved by the Technician. Fill shall be placed beginning at the lowest elevation of the foundation. No fill shall be placed on a frozen surface.

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

Available topsoil shall be placed on the top and the exposed outside slopes of the waste storage facility embankment, the borrow areas, and any other area where the topsoil was removed during construction and where vegetation will be established.

The pre-compacted thickness of each layer of fill and compaction requirements shall be as stated below unless otherwise specified in the construction plans. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified layer thickness prior to

compaction. The Technician shall determine if adequate compaction is being achieved and may require more than the minimum specified passes of the compaction equipment.

(a) Embankments. The fill shall be placed in horizontal layers extending the entire length and width of the embankment. Unless otherwise specified in the construction plans, compaction requirements shall be as shown in Table 1. Each layer shall be compacted by a minimum of one pass over the entire surface of the fill by the compaction equipment.

(b) Adjacent to Structures and Pipes. Adjacent to structures or pipes, earthfill shall be placed in 4-inch lifts (prior to compaction) in a manner adequate to prevent damage to the structure and to allow the structure or pipe to gradually and uniformly assume the backfill loads. Compaction shall be accomplished by means of manually directed power tampers or plate vibrators or hand tamping unless otherwise specified. Heavy equipment shall not be operated within 2 feet of any structure or pipe. Compaction by means of drop weights operating from a crane or hoist of any type will not be permitted.

All intrusions into or penetrations of a clay or other soil liner will be backfilled with equivalent material and compacted to maintain its integrity. Pipe trenches into a storage facility will be backfilled with the same soils and compaction required for the storage facility for the distance shown on the drawings.

(c) Clay Liners. A clay liner shall be installed as designated on the drawings. This work shall consist of constructing an impermeable earthliner for the inside slopes and the bottom of the earthen basin to the thickness shown on the drawings. It also includes the liner material placed in conjunction with other liner materials to form a composite liner as shown on the drawings. Only soils approved by the Technician will be used.

The liner fill shall be placed in layers with a maximum thickness of 6 inches prior to compaction. The liner material shall be disked or worked in such a manner as to obtain a maximum clod size of 4 inches prior to compaction. Each layer shall be compacted by a minimum of one pass over the entire surface of the fill by a fully-loaded rubber-tired front end loader or scraper or a sheepsfoot or tamping roller. Smooth drum rollers are not suitable for compaction of clay liners. Operation of the compaction equipment will be continuous over the entire area during fill operations. Any liner area disturbed by subsequent construction operations will be scarified and recompacted as specified.

(d) Small Areas of Unsuitable Materials. Lenses or pockets of soil not meeting the criteria requirements in NRCS Standard 313 shall be removed and replaced with specified materials. The extent of removal and the quality of replacement materials will be as shown on the drawings or approved by the Technician. Excavated slopes shall be 1:1 or flatter. Replacement soil material placement, layer thickness, and compaction will be as stated for clay liners. Manually directed power tampers may be used for compaction and the soil shall be placed in 4-inch lifts prior to compaction.

Table 1 - Embankment Compaction Requirements

Equipment Type	Applicable Soils[1]	Maximum Fill Height[2] (feet)	Layer Thickness[3] (inches)
Sheepsfoot or tamping roller 10,000 lb. min. operating weight	ML, MH, CL, CH SM, SC, GM, GC	None	9
Vibratory tamping roller 9,000 lb. min. operating weight	SM, SC, GM, GC	None	6
Smooth drum vibratory roller 10,000 lb. min.	SP, SW, GP GW	20	6
Rubber-tired scraper (fully loaded)	ML, MH, CL, CH SM, SC, GM, GC	None	9
Rubber-tired front end loader (fully loaded)	ML, MH, CL, CH SM, SC, GM, GC	20	6
Track-type crawler standard tracks 30,000 lb. min.	SM, SC, GM, GC, ML, CL SP, SW, GP, GW	10	6
Farm tractor 2,400 lb. min.	ML, MH, CL, CH, SM, SC, GM, GC	15	6

[1] Unified Soil Classification System.

[2] Measured from the top of the fill to the lowest point along the centerline of the fill.

[3] Prior to compaction.

WISCONSIN CONSTRUCTION SPECIFICATION

300. CLAY LINER

1. SCOPE

The work shall consist of the construction of the clay liner as shown on the construction plans.

2. CLAY LINER MATERIAL

Clay liner material shall have a minimum plasticity index of 12 (PI $\geq$12) and a minimum percentage passing the No. 200 sieve (P_{200}) as specified in the construction plans. The clay liner material shall be capable of providing a liner with a maximum hydraulic conductivity (permeability) of 1 x 10^{-7} centimeters per second.

Proposed liner material properties shall be determined in the lab prior to placement for each different borrow area and material, at the specified minimum frequency shown in Table 1. These tests are typically done in the design phase with additional tests required when unpredicted changes in borrow material are observed.

A standard or modified proctor test density curve, and optimum moisture, shall be developed from the borrow materials. A hydraulic conductivity (permeability) shall be determined on a re-compacted sample. The sample shall be re-compacted to the minimum density and moisture content specified in Section 6, Compaction.

Table 1 Borrow Material Testing

Test Reference	Minimum Frequency
Standard Proctor (ASTM D 698) or Modified Proctor (ASTM D 1557)	1 per 5,000 cubic yards of estimated in-place liner quantity
Atterberg Limit (ASTM D 4318) and Percent Fines (ASTM D 1140)	1 per 5,000 cubic yards of estimated in-place liner quantity
Permeability (ASTM D 5084)	1 per 5,000 cubic yards of estimated in-place liner quantity

3. FOUNDATION PREPARATION

Foundation surfaces shall be graded to remove surface irregularities and shall be scarified or otherwise acceptably scored or loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the clay liner. The surface materials of the foundation shall be compacted and bonded with the first layer of the clay liner as specified for subsequent layers of clay liner.

4. PLACEMENT

The clay liner shall not be placed until the required foundation preparation has been completed and the foundation has been inspected and approved by the Technician or Engineer. The clay liner shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the clay liner.

Clay materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Rock particles larger than 3 inches shall be removed prior to compaction of the clay.

The clay liner shall be placed in lifts. The thickness of each lift before compaction shall not exceed the smaller of 6 inches or the length of the teeth of the footed compactor used.

The distribution of materials throughout the clay liner shall be essentially uniform, and the clay liner shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified to a depth of not less than 2 inches before the next layer is placed.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of the clay liner, the moisture content of the clay being placed shall be maintained above optimum moisture as determined by the standard proctor test or modified proctor test.

The application of water to the clay shall be accomplished at the borrow areas in-so-far as practicable. Water may be applied by sprinkling the clay after placement and before compaction of the liner, if necessary. Uniform moisture distribution shall be obtained by disking.

6. COMPACTION

The clay liner shall be compacted to a minimum of 95% of standard proctor dry density or to a minimum of 90% of modified proctor dry density. The moisture content shall be above the optimum moisture.

The clay liner shall be compacted with a footed compactor weighing at least 25,000 pounds, operated continuously.

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE LINER

Clay liner placed at densities lower than the specified minimum density or at moisture contents lower than optimum moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the specifications or removed and replaced. The replacement clay material and the fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

8. TESTING METHOD SPECIFICATIONS

- ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
- ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
- ASTM D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D 1140 Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 μm) Sieve
- ASTM D 2922 Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D 2937 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
- ASTM D 2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

- ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
- ASTM D 5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

9. TESTING FREQUENCY

Clay liner construction shall be tested and documented by a third party engineering or testing firm at the specified minimum frequency shown in Table 2.

Field density tests shall be completed on the compacted in-place clay liner, as the liner is being placed. Atterberg limit and percent fines shall be completed on samples obtained next to the field density test. After the completion of the liner, undisturbed samples shall be taken from the constructed clay liner for permeability verification.

Copies of the test locations and test results (documentation report) shall be provided to the owner to document compliance with this specification.

Table 2 Liner Testing

Test Reference	**Minimum Frequency** (Standard mathematical rounding rules apply)
Field Density (ASTM D 2922, or D 2937, or D 2167, or D 1556)	1 test per 500 cubic yards of in-place liner, distributed throughout the structure (Horizontally and Vertically)
Atterberg Limit (ASTM D 4318) and Percent Fines (ASTM D 1140)	1 test per 2000 cubic yards of in-place liner
Permeability (ASTM D 5084)	1 per 5,000 cubic yards of in-place liner (2 minimum per facility)[1]

1. At least one of these tests should be obtained from the side slope of the facility

All undisturbed sample test holes in the constructed clay liner shall be backfilled using powdered bentonite mixed with clay soil used in liner construction and compacted by hand tamping. The clay shall be broken down into clods less than ½ inch in diameter. A minimum of 25% of each backfilled test hole volume shall be occupied by powdered bentonite after backfilling.

Relevant WDNR

Conservation Practice Standards

Chapter NR 213

LINING OF INDUSTRIAL LAGOONS AND DESIGN OF STORAGE STRUCTURES

Note: Corrections made under s. 13.93 (2m) (b) 5. and 7., Stats., Register, September, 1997, No. 501.

Subchapter I — General

NR 213.01 Purpose. The purpose of this chapter is to protect public health and welfare by restoring, maintaining and protecting the physical, chemical and biological integrity of the waters of the state and all uses of state groundwaters and surface waters in accordance with the provisions of ch. NR 140, and chs. 160 and 283, Stats.; and to establish minimum design standards, material requirements and performance criteria for all lagoons, storage structures or treatment structures that are regulated under ss. 281.41 and 283.31, Stats., and ch. NR 108, except those storage structures or treatment structures listed in s. NR 213.02 (2).

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; r. and recr. Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.02 Applicability. (1) STRUCTURES REGULATED. This chapter is applicable to all lagoons, tanks, stacking structures, and other storage or treatment structures that receive industrial, commercial or agricultural wastewaters, associated sludges from industrial, commercial or agricultural sources, by−product solids and any resulting leachates. The performance criteria of this chapter may also be applicable to facilities that store other materials such as coal and road salt and the resulting runoff or leachate.

(2) STRUCTURES EXCLUDED. This chapter is not applicable to:

(a) Land disposal systems, such as absorption ponds, which are regulated under ch. NR 214 or ch. 283, Stats.

(b) Lagoons licensed under ch. NR 132, 182, 500, 502, 504, or 660, or approved under subch. III of ch. 295, Stats.

(c) Lagoons used solely for research purposes under the direction of a Wisconsin registered professional engineer, soil scientist, geologist or a scientist employed by a university located within this state, if approved by the department and provided the following requirements are met.

1. The size of the lagoon does not exceed one acre.

2. The lagoon is developed, operated and maintained in a safe nuisance−free manner so that no pollutants enter waters of the state.

3. Copies of the research proposal are submitted to the department prior to initiating construction and any resulting reports or publications on the research are provided to the department.

(d) Lagoons and storage structures designed, constructed and used solely for the storage of animal wastes.

(e) Sweet corn silage stacks which are utilized for direct feeding of livestock, have less than 150 tons on a site at any one time and are located such that surface water or groundwater pollution do not occur.

(f) All existing above ground and in−ground storage structures constructed of concrete, glass reinforced plastic or steel which are watertight and are used for the treatment or storage of wastewater.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; r. and recr. Register, June, 1990, No. 414, eff. 7−1−90; **CR 13−057: am. (2) (b) Register July 2015 No. 715, eff. 8−1−15.**

NR 213.03 Existing lagoons, storage structures and treatment structures. (1) Owners and operators of lagoons, storage structures and treatment structures existing prior [to] July 1, 1990 shall demonstrate to the satisfaction of the department that all existing lagoons, storage structures and treatment structures, except those structures listed in s. NR 213.02 (2), meet the purpose of this chapter by as soon as reasonably possible but no later than 5 years from July 1, 1990 or as specified by a WPDES permit.

(2) A report evaluating compliance with the design standards, material specifications and performance criteria in this chapter shall be submitted to the department within 2 years of July 1, 1990 unless otherwise specified by a WPDES permit or other notification by the department.

(b) In the event that the owner cannot demonstrate compliance with all of the design standards and material requirements with the existing facility, the generator may request an exemption from the design standards and material requirements of this chapter in accordance with s. NR 213.06.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; r. and recr. Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.04 Definitions. The following definitions apply to the terms used in this chapter. Definitions of other terms and meanings of abbreviations are set forth in ch. NR 205.

(1) "ASTM" means the American Society for Testing and Materials. Copies of ASTM standards referenced in this chapter are available for inspection at the offices of the department of natural resources, the secretary of state's office and the legislative reference bureau. ASTM standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

(2) "Base course" means the layer or layers of specified or selected material of designed thickness placed on a subbase or subgrade to support a surface course.

(3) "Bedrock" means the rocks that underlie soil material or are at the earth's surface which are encountered when the weathered in−place consolidated material, larger than 2 mm in size, is greater than 50% by volume.

(4) "By−product solids" means waste solid products, including but not limited to cuttings or peelings generated at processing facilities, fresh or actively fermenting sweet corn silage, other food wastes and paunch manure.

(5) "Coefficient of permeability" means the rate of discharge of water under laminar flow conditions, through a unit cross−

sectional area of porous medium, under a unit hydraulic gradient and standard temperature.

(6) "Community public water supply system" means a water supply system having at least 15 service connections used by year−round residents or regularly serving at least 25 year−round residents. Any water supply system serving 7 or more homes, 10 or more mobile homes, 10 or more apartment units, or 10 or more condominium units shall be considered a community public water supply system unless information is available to indicate that 25 year−round residents will not be served.

(7) "Detrimental effect" means contamination of the lands or waters of the state, or making the same injurious to public health, harmful for commercial or agricultural use, or deleterious to animal or plant life.

(8) "Floodway" has the meaning specified under ch. NR 116.

(9) "Groundwater" means any of the waters of the state, as defined in s. 281.01 (18), Stats., occurring in a saturated subsurface geological formation of rock or soil.

(10) "Groundwater monitoring" means measuring the groundwater level and analyzing samples of water taken from the ground.

(11) "Lagoon" means a natural or human−made containment structure, constructed primarily of earthen materials and used for the treatment or storage of industrial, commercial or agricultural wastewater, biological fermentation leachates or sludge.

(12) "Pavement structure" means the combination of subbase, base and surface courses placed on a subgrade.

(13) "Potable water supply well" means a well supplying water for human consumption, sanitary use or food product preparation.

(14) "Storage structure" means either an earthen containment structure or a storage tank used for the storage of wastewater or biological fermentation leachates or a structure constructed for stacking and storage of by−product solids or other material.

(15) "Storage tank" means a containment vessel fabricated of concrete, glass−reinforced plastic or steel for the purpose of storage or treatment of wastewater or biological fermentation leachates.

(16) "Subbase" means the layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course.

(17) "Subgrade" means the ground surface upon which the pavement structure is constructed.

(18) "Surface course" means the layer or layers of specified material of designed thickness placed on a base course and forming the upper portion of a pavement structure. If more than one layer is specified, the bottom layer is referred to as the binder course.

(19) "Treatment structure" means either an earthen treatment structure or a treatment tank used for the chemical, physical or biological treatment of wastewater or biological fermentation of leachates or a structure constructed for chemical, physical or biological treatment of by−product solids or other material.

(20) "Wetlands" has the meaning specified under s. 23.32, Stats.

(21) "WDOT standards for roads and bridge construction" means the Wisconsin department of transportation standard specifications for road and bridge construction, edition of 1989.

Note: Copies of the WDOT standards may be inspected at the offices of the department, the secretary of state and the legislative reference bureau.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; r. and recr. Register, June, 1990, No. 414, eff. 7−1−90; correction in (1) made under s. 13.92 (4) (b) 6., Stats.

NR 213.05 Additional requirements. The design standards, material requirements or performance criteria of this chapter may be supplemented or superseded by more stringent requirements, including pretreatment requirements, more stringent design limitations, and more frequent or stringent effluent or groundwater monitoring requirements, if:

(1) There is an increased possibility of groundwater contamination due to structure location, soil types, geologic condition or other conditions, or

(2) The stored or treated material may contain any substance or concentration of substances not normally associated with the type of discharges identified in s. NR 213.02 (1), such as toxic substances or hazardous wastes, or

(3) The storage structure or treatment unit may cause a public nuisance.

History: Cr. Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.06 Exemptions from ch. NR 213. (1) The department may allow exemptions from the design standards and material requirements described in this chapter if the owner or operator can demonstrate that such design standards and material requirements are more stringent than necessary to comply with the provisions of ch. NR 140 and chs. 160 and 283, Stats. The owner or operator shall justify such an exemption from the design standards and material requirements of this chapter by demonstrating that the alternative design will comply with the following performance criteria:

(a) That pollutant dilution, dispersion or degradation will occur within the design management zone as defined in ch. NR 140;

(b) That increases of substances in the groundwater from lagoons, storage structures and treatment structures at the site will be minimized to the extent technically and economically feasible; and

(c) That applicable groundwater and surface water standards will not be exceeded.

(2) The department shall consider the following factors when reviewing an alternative design in consideration of granting an exemption:

(a) Physical characteristics of the site, such as soil texture, soil permeability, depth to groundwater and depth to and type of bedrock.

(b) Age and condition of an existing structure.

(c) Analytical data from existing groundwater monitoring wells or any that may be installed as part of the demonstration.

(d) The quantity and composition of the materials stored or treated at the facility.

(e) The compatibility between the materials stored or treated and the lining of the storage or treatment unit.

(f) Any other information relevant to the environmental impacts of the facility's operations.

(3) SUBMITTING AN EXEMPTION REQUEST−NEW OR MODIFIED STRUCTURES. The owner or operator of a new or modified lagoon, storage structure or treatment structure may request an exemption from the design standards and material requirements of this chapter by submitting facts to the department:

(a) In the application for issuance, reissuance or modification of WPDES permit, or

(b) In plans and specifications for a new or expanded lagoon, storage structure or during the 90−day plan approval period as specified in s. 281.41, Stats., or

(c) During the 30−day public comment period following public notice by the department of intent to issue, reissue or modify a WPDES permit under s. 283.39, Stats., or

(d) At a public hearing held under s. 283.49 or 283.63, Stats.

(4) SUBMITTING AN EXEMPTION REQUEST−EXISTING STRUCTURES. The owner or operator of a lagoon, storage structure or treatment structure in existence prior to July 1, 1990 may request an exemption from the design standards and material requirements of this chapter. If an exemption is not granted, the department shall propose to issue a new WPDES permit or modify the

existing WPDES permit to include a schedule of compliance to achieve the purpose of this chapter.

History: Cr. Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.07 Abandonment. Lagoons, storage structures and treatment structures which will no longer be used, shall be properly abandoned within 2 years of the date on which waste material was last stored or treated. A plan outlining the proposed method of abandonment shall be submitted to the department for approval. This plan shall contain a procedure to properly identify the presence and characteristics of any accumulated solid waste and provide appropriate removal, disposal or recycling or treatment alternatives in accordance with applicable solid and hazardous waste laws. All recycling, treatment and disposal shall be conducted so as to protect public health and the environment. Unless otherwise directed by the department, all abandonment plans shall comply with ch. NR 720 for soils that have been contaminated by the contents of the lagoon, storage structure or treatment structure. The plan shall also address site restoration and any landscaping that will prevent accumulation of standing water or runoff. The department may require groundwater monitoring for a period of time after abandonment of the land treatment system to assess groundwater impacts. The design, installation, construction, abandonment and documentation of all monitoring wells shall be in accordance with the requirements of ch. NR 141.

History: Cr. Register, June, 1990, No. 414, eff. 7−1−90; am., Register, April, 1994, No. 460, eff. 5−1−94; am., Register, March, 1995, No. 471, eff. 4−1−95.

NR 213.08 General design requirements. (1) LOCATION. (a) Lagoons, storage structures and treatment structures may not be located closer than:

1. 1,000 feet from a well serving a community public water supply system.

2. 250 feet from other potable water supply wells.

3. 500 feet from an inhabited dwelling except that this distance may be reduced with written permission from the owner and occupants of the residence. The department may require a greater distance depending on the type of lagoon, storage structure or treatment structure and potential for aesthetic impacts and public health impacts.

(b) Lagoons, storage structures and treatment structures may not be located in the floodway and shall conform with the requirements of ch. NR 116.

(c) Lagoons, storage structures and treatment structures may not be located within wetlands.

(d) Lagoons, storage structures and treatment structures shall be designed and operated to minimize the level of substances in the groundwater and to prevent exceedance of the groundwater preventive action limits (PAL) to the extent technically and economically feasible. Groundwater preventive action limits are listed in ss. NR 140.10 and 140.12.

(2) BASIC CONSTRUCTION DESIGN. (a) Effective erosion protection of exterior slopes of lagoons shall be provided by appropriate means, such as riprap or seeding with grass.

(b) Lagoons shall be maintained as necessary to prevent scouring of the liner and liner cover, discourage vegetative growth, and avoid desiccation and cracking of the liner.

(c) A minimum separation of 5 feet shall be maintained between the bottom of the lagoon liner or subbase of a storage structure and either bedrock or the groundwater level, whichever is higher.

(3) GROUNDWATER MONITORING. (a) A groundwater monitoring system designed and constructed in accordance with ch. NR 141 may be required by the department to provide information on the long term effects of a lagoon, storage structure or treatment structure on groundwater.

(b) When a groundwater monitoring system is required, the parameters to be monitored and the monitoring frequency will be established on a case−by−case basis.

(4) ADDITIONAL DESIGN REQUIREMENTS. In cases where critical groundwater, geologic or construction conditions warrant, the department may require construction specifications or testing requirements more stringent than those described in this chapter if necessary to preclude detrimental effects to the groundwater.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; renum. from NR 213.05 and am. Register, June, 1990, No. 414, eff. 7−1−90.

Subchapter II — Lining of Industrial Lagoons

NR 213.09 General submittal requirements. (1) GENERAL. An engineering report and plans and specifications shall be submitted to the department for approval in accordance with s. 281.41, Stats., prior to initiating construction.

(a) The department recommends, whenever possible, a preliminary engineering report outlining the project and including any available information required under par. (b) be made prior to submittal of final plans.

(b) The engineering report shall outline the entire project and include, at a minimum, the following information: subsurface site conditions, waste sources, waste analysis and waste volume; materials and specifications of the proposed liner required under ss. NR 213.10 and 213.11; compatibility of the waste and proposed liner and estimated life of the liner required under sub. (4); the proposed method of installation, and the equipment and testing methods to be used for quality control both during and after construction.

(c) The plans and specifications shall include the existing and finished elevations and adequate details to fully illustrate the proposed installation.

(d) When a groundwater monitoring system is required under s. NR 213.08 (3), an engineering report and plans and specifications shall be submitted and shall include: a discussion of the installation, the proposed materials to be used, and the method of construction and location of all proposed wells.

(2) SUBSURFACE INVESTIGATION. (a) Reports on subsurface site conditions shall include boring logs, particle size distribution and soil classifications for each major lithologic unit and the depths to groundwater and bedrock when encountered. When on−site soil is proposed as the lining material, compaction curves, permeabilities and Atterberg limits shall be established for the soil proposed for the lining material.

(b) Sufficient soil borings shall be performed at each proposed lagoon site to adequately define the subsurface soil conditions and depth to groundwater and bedrock at the site. A minimum of 3 borings for the first acre and one boring for each additional acre or portion of an acre shall be performed. The borings should be distributed in a grid pattern over the entire site. In no case may less than 3 borings be performed. The department may require additional borings depending upon the size of the lagoon, proposed liner, waste material, or known or anticipated critical hydrogeologic conditions at the site.

(c) All soil borings shall extend a minimum of 10 feet below the proposed base grade of the lagoon, or to groundwater or bedrock, whichever is less.

(d) Soil borings shall be performed by or under the supervision of a qualified soil testing laboratory, engineering firm, or other individual or firm which has demonstrated the capability to perform such work.

(e) Measurement of the resistance of the soil to penetration and the collection of soil samples shall be performed every 5 feet and at all significant changes in soil type or lithology in each soil boring.

(f) All soil samples shall be analyzed for particle size distribution and classified texturally.

(g) When required under s. NR 213.08 (3), groundwater monitoring wells may be installed in the soil boring holes provided these holes are located adequately to assure representative monitoring of both upgradient and downgradient groundwater conditions.

(3) WASTE ANALYSIS. (a) Representative samples of all wastewater, sludge or other materials to be placed in the lagoon shall be analyzed to determine the composition of the samples. Past analyses may be used, provided they are representative of the wastewater, sludge or other materials to be discharged to the lagoon.

(b) Sludge shall be analyzed on both a total solids and an extracted pore water basis.

(c) The parameters analyzed for may include BOD_5, COD, pH, alkalinity, specific conductance, chloride, sulfate, sodium, calcium, magnesium, total dissolved solids, hardness, or any other constituents or properties known or suspected to be detrimental to the integrity of the proposed liner.

(d) For all facilities, estimated wastewater characterization shall be provided, along with the basis for the estimates.

(4) WASTE AND LINER COMPATIBILITY. (a) Compatibility between the waste and the proposed liner shall be addressed and documented. Prior research or data from similar existing sites shall be included when available. If specific testing is performed, all test procedures used shall be detailed and the results provided.

(b) For synthetic and soil−bentonite liners, written confirmation of compatibility, as well as the estimated design life of the liner against the waste in question, shall be provided by the manufacturer of the synthetic liner or bentonite.

(c) The department may require controlled long term compatibility testing such as column studies, permeability or immersion tests to determine long−term changes in permeability, soil structure or physical properties of the liner.

(5) SAMPLING AND TESTING STANDARDS. (a) Soil samples taken to determine soil classification, particle size distribution or permeability shall be taken in accordance with ASTM D1586 (1984), ASTM D1587 (1983) or ASTM D3550 (1984).

(b) Coefficient of permeability of the constructed soil or soil−bentonite liner shall be determined using a laboratory permeability test on hydrated and saturated specimens of the liner material, compacted at the same approximate density as exists in the in−field condition. Tests may be performed on remolded or core samples. The permeability shall be based on stabilized inflow and outflow rates during the test. Separate tests shall be performed using tap water and the wastewater or sludge extract, and the results compared. All preparation work and information detailing the test apparatus shall be submitted along with all results obtained.

(c) Particle size analyses to determine particle size distribution of soil samples shall be performed in accordance with ASTM D422 (1972).

(d) Plasticity index shall be determined in accordance with ASTM D4318 (1984).

(e) Measurement of the resistance of soil to penetration shall be determined in accordance with ASTM D1558 (1984) or ASTM D1586 (1984).

(f) Standard proctor densities shall be determined in accordance with ASTM D698 (1978).

(g) Soils shall be classified texturally according to the Unified Classification System.

(h) In−place density may be determined in accordance with ASTM D2922 (1981) or ASTM D2937 (1983).

(i) Other methods of sampling and testing may be approved by the department on a case−by−case basis.

Note: Copies of ASTM D1586, D1587, D3550, D422, D424, D15558, D698, D2922 and D2937 may be inspected at the office of the department, the secretary of state and the legislative reference bureau. Copies of ASTM standards may also be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; renum. from NR 213.06 and am. (1) (a), (b) and (d), (2) (g), (3) (a), (d) and (5) (i), Register, June, 1990, No. 414, eff. 7−1−90; am. (5) (a), (d), (e) and (h), Register, April, 1991, No. 424, eff. 5−1−91.

NR 213.10 General liner specifications. (1) GENERAL. (a) All lagoons shall be sealed to prevent excessive exfiltration.

1. Natural soil materials, soil−bentonite mixtures or synthetic liners approved by the department may be used as lagoon liners.

2. All liners shall be constructed with materials compatible with the wastewater to be contained by the lagoon.

3. Prior to installation of any type of liner, the lagoon bottom shall be compacted to a depth of 6 inches, at a minimum to 95% of the maximum standard proctor dry density, at or above optimum moisture.

4. All liners shall be constructed to provide a uniform barrier to exfiltration across the lagoon bottom, interior dike walls and extending up the dike wall to the berm.

5. The department may require a liner to be protected by an inorganic layer of soil or crushed stone if necessary to protect against such things as photochemical reaction, ice or wave action, freeze−thaw action, liner floatation or vehicular traffic on the liner. This layer shall have a minimum thickness of one foot and be uniformly graded and free from large rocks, soil clumps and sticks. If a granular noncohesive soil is used, the department may require that a soil fabric securely attached to the berm be placed between the liner and the cover material to prevent slumping of the cover material.

6. Riprap may be required along the air−water interface if necessary to minimize rodent activity or exposure and erosion of the liner or subgrade.

7. For lagoons which will be empty for extended periods of time, a synthetic lining material shall be used to prevent liner degradation as a result of desiccation.

(b) Soil or soil−bentonite liners. 1. The design standard for the co−efficient of permeability of soil or soil−bentonite liners may not exceed 1×10^{-7} cm/sec.

2. The thickness of soil or soil−bentonite liners shall be determined according to Darcy's equation and shall include an appropriate safety factor for construction variability. See Table 1.

Table 1
Minimum Required Liner Thickness (inches)
For Natural Soil and Soil−Bentonite Liners

Coefficient of Permeability of the Liner cm/sec (ft/day)	Wastewater Depth (ft.) 4	6	8	10	12	14	16
1×10^{-7} (2.82×10^{-4})	12	16	20	25	29	34	38
5×10^{-8} (1.41×10^{-4})	12	12	12	13	16	18	20

For all permeabilities less than those shown above, regardless of the wastewater depth, the minimum liner thickness shall be 12 inches.

3. To a depth of 6 inches, a minimum of 15% of the unmodified soil upon which a soil or soil−bentonite liner is to be constructed shall pass a No. 200 sieve. If this requirement cannot be met, a soil filter fabric designed to retain those particles passing a No. 200 sieve shall be placed between the liner and the existing soil.

4. Soil or soil−bentonite liners shall be compacted at or above optimum moisture.

5. A means shall be provided to prevent soil or soil−bentonite liners from desiccating after completion of construction and prior to placing the lagoon into operation.

(2) EXFILTRATION RATE. (a) The design loss of wastewater or sludge from any lined lagoon may not exceed 500 gallons per acre per day.

(b) In circumstances where soil characteristics, groundwater quality, waste characteristics or concern with the liner−waste compatibility warrant, the department may require that more stringent exfiltration rates be met.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; renum. from NR 213.07 and am. (1) (b) 2. and (2) (b), Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.11 Specific liner specifications. (1) NATURAL SOIL LINER SPECIFICATIONS. (a) Natural soil liners shall consist of soils of which a minimum of 50% of the soil particles pass a No. 200 sieve.

(b) Natural soil to be used as a liner shall contain less than 2% organic material, and less than 5% by weight of the natural soil to be used shall be retained on a No. 4 sieve.

(c) Natural soil to be used as a liner shall have a plasticity index of at least 15.

(d) Natural soil liners shall be compacted to at least 95% of the maximum standard proctor dry density.

(e) Natural soil liners shall be constructed and compacted in lifts. A lift may not exceed a compacted thickness of 6 inches.

(f) Frost susceptible soils may not be used to construct a natural soil liner. Silts and silty sands shall be considered frost susceptible.

(g) When constructing natural soil liners with native in−place soils, the subbase shall be scarified prior to compaction. Subsequently, the existing base shall be scarified prior to placement of each successive lift.

(h) Natural soil liners shall be constructed under the direct supervision of a qualified soils technician or engineer, or geotechnical engineer.

(2) SOIL−BENTONITE LINERS. (a) The soil to be mixed with the bentonite shall have a plasticity index of at least 12, a minimum of 30% of the soil by weight shall pass a No. 200 sieve, and less than 5% by weight shall be retained on a No. 4 sieve.

(b) Bentonite shall be applied at a rate recommended by the manufacturer or an independent soil expert. Completed soil−bentonite liners shall contain a minimum of 5% bentonite by dry weight.

(c) Ninety percent of the bentonite by weight shall pass a No. 80 sieve.

(d) Bentonite shall be thoroughly admixed with the soil throughout the entire thickness of each lift.

(e) Soil−bentonite liners shall be compacted to at least 85% of the maximum standard proctor dry density.

(f) Soil−bentonite liners shall be constructed under the direct supervision of a qualified representative of the bentonite manufacturer, soil technician or engineer, or geotechnical engineer.

(3) SYNTHETIC LINERS. (a) Synthetic liners shall have a minimum thickness of 30 mils.

(b) Synthetic liners shall be installed under the direct supervision of a qualified manufacturer's representative.

(c) To a depth of 6 inches below the bottom of synthetic liners, the soil shall be free from large rocks, angular stones, soil clumps, sticks or other material which may puncture the liner.

(d) Synthetic liners shall be securely anchored into the dike berm.

(e) Venting shall be provided beneath synthetic liners to prevent failure as a result of backpressure from gas accumulation or fluctuations in the watertable elevation. If a liner cover is provided, this requirement may be waived.

(f) Prior to constructing synthetic liners, the underlying soils shall be treated with an herbicide in accordance with the manufacturer's recommendations.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; renum. from NR 213.08, Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.12 Quality assurance and testing requirements. (1) GENERAL. (a) All liners shall be tested before the lagoons are put into operation to ensure that all performance standards and design specifications as approved have been met. A post−construction report shall be submitted to the department for approval prior to discharging any wastes into the lagoons. The report shall include: all material test results required under sub. (2) or (3); plan sheets illustrating final elevations, slopes and test locations; a discussion of weather conditions and any unexpected conditions encountered during construction.

(b) Testing shall be performed in accordance with sub. (2) or (3), or any other method approved by the department.

(c) All tests shall be performed under the direct supervision of the design engineer except for tests on synthetic or soil−bentonite liners, which shall be performed under the direct supervision of a representative of the manufacturer unless otherwise specified by the department in the plan approval.

(2) SOIL OR SOIL−BENTONITE LINERS. (a) Following completion of construction and prior to being put into use, core samples of soil or soil−bentonite liners shall be taken in accordance with ASTM D1587 (1983). A minimum of 5 samples per acre of liner surface shall be taken. The samples shall be split proportionately between the wetted areas of the bottom and interior walls of the dikes relative to the total area of each and spaced to provide representative samples of the liner. For lagoons less than one acre in size, a minimum of 5 samples shall be taken.

(b) The core samples shall be tested by a soil testing laboratory or engineering firm for the following parameters: dry unit weight density, moisture content, degree of compaction, liner thickness, particle size distribution and Atterberg limits. Additionally, permeability tests shall be performed on a minimum of 3 of every 5 core samples. The design standards for liner thickness and permeability shall be considered met if:

1. The average thickness of soil or soil−bentonite liners and cover samples, analyzed separately, are equal to or greater than the specified design thickness; and

2. An individual sample does not have a thickness which is less than the design thickness by more than 0.1 foot; and

3. The permeability of at least 60% of the liner samples tested are equal to or less than the design permeability; and

4. An individual sample does not have a permeability more than one order of magnitude greater than the design permeability.

(c) All test holes shall be backfilled using materials identical to the liner design materials and compacted.

(3) SYNTHETIC LINERS. Subsequent to installation of synthetic liners and prior to placement of the liner cover, all field constructed seams shall be tested in accordance with the manufacturer's recommendations to insure the integrity of the liner. All faulty seams shall be repaired and retested until a proper seal is obtained.

Note: Copies of ASTM D1587 may be inspected at the offices of the department, the secretary of state and the legislative reference bureau. Copies of ASTM standards may also be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

History: Cr. Register, July, 1984, No. 343, eff. 8−1−84; renum. from NR 213.09, Register, June, 1990, No. 414, eff. 7−1−90; am. (2) (a), Register, April, 1991, No. 424, eff. 5−1−91.

Subchapter III — Design of Storage Structures

NR 213.13 Requirements for sweet corn silage stacks of greater than 150 tons which do not exceed 1200 tons at any one time. Sweet corn silage stacks which do not exceed 1200 tons per site at any one time are not required to meet the specifications of s. NR 213.14 if subs. (1), (2) and (3) are

met. This section does not apply to sweet corn silage stacks of less than 150 tons per site at any one time.

(1) GENERAL SITE CRITERIA. Sites used for stacking of sweet corn silage which do not exceed 1200 tons per site at any one time shall meet the following conditions:

(a) At least 50% of the natural soil in the upper 24 inches passes a No. 200 sieve.

(b) No greater than 5% by weight of the upper 24 inches of the natural soil is retained on a No. 4 sieve.

(c) The plasticity index of the natural soil is equal to or greater than 7.

(d) The stack is located at least 1000 feet from any well serving a community public water supply system and at least 250 feet from any other potable water supply well.

(e) The stack is located at least 500 feet from an inhabited dwelling except that this distance may be reduced with the written permission from the owner and occupants of the residence.

(f) The stack is located at least 5 vertical feet from the groundwater or bedrock.

(g) The base of the stack is located on a site that does not exceed 2% slope.

(h) The stack is located at least 200 feet from the nearest surface water.

(2) LEACHATE MANAGEMENT. Leachate from the stack shall be collected and landspread in a manner that prevents surface water and groundwater pollution.

(3) DOCUMENTATION OF COMPLIANCE. Documentation of compliance with subs. (1) and (2) shall be submitted to the department for review and acceptance prior to use of the site for stacking of sweet corn silage.

History: Cr. Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.14 Stack structures for by−product solids.

This section shall be applicable to all by−product solids stacks except those stacks identified in s. NR 213.02 (2) (e) or those stacks which meet the requirements of s. NR 213.13.

(1) GENERAL SUBMITTAL REQUIREMENTS. (a) An engineering report and plans and specifications shall be submitted to the department for approval in accordance with s. 281.41, Stats., prior to initiating construction.

Note: The department recommends that whenever possible, a preliminary engineering report outlining the project and including any available information required under par. (b) be submitted prior to submittal of final plans.

(b) The engineering report shall outline the entire project and include, at a minimum, the following information: legal description of the site subgrade conditions, soil classification, percent soil passing a No. 200 sieve, soil plasticity index, depth to bedrock and to seasonal high groundwaters, waste sources, and waste volume and materials and specifications of the proposed structure.

(2) GENERAL DESIGN AND CONSTRUCTION CRITERIA. (a) The base, walls and joints of the by−product solids stack structure shall be constructed for maximum containment of any leachate generated such that all leachate is conveyed to and stored in an approved leachate storage facility.

(b) The minimum slope for the base of the structure shall be 2%.

(c) Construction of bituminous concrete structures and concrete structures shall comply with the WDOT standards for road and bridge construction. Other materials for stack structures may be proposed in the plans and specifications submitted to the department. Approval of any material shall be based on the capability of the material to meet the purpose of this chapter.

Note: Copies of WDOT standards may be inspected at the offices of the department, the secretary of state and the legislative reference bureau.

(3) SITE PREPARATION. (a) Prior to construction, the site area shall be cleared of all vegetation, brush, roots and stumps. Materials encountered above the required elevations shall be excavated and all depressions in the subgrade shall be filled. The subgrade shall be smoothed, shaped and compacted to the required grade, section and uniform density. The subgrade shall be scarified to the depth necessary for shaping and compaction. Stones over 6 inches in diameter shall be removed during site preparation.

(4) BITUMINOUS CONCRETE STRUCTURE DESIGN AND CONSTRUCTION CRITERIA. (a) The pavement structure shall consist of a minimum of 10 inches of well drained subgrade or subbase. A suitable subgrade is one with 35% or less passing a No. 200 sieve, and a plasticity index of 10 or less. The base course shall contain a minimum 8 inches of crushed aggregate and the surface course shall be 3 inches of bituminous concrete pavement in 2 layers.

(b) The aggregates of the base course shall conform to the gradation requirements for gradation No. 2 in accordance with sec. 304.2.6 WDOT standards for road and bridge construction.

(c) The aggregates of the bituminous concrete pavement may not be of dolomitic or limestone origin.

(d) The bituminous concrete pavement shall be laid in 2 lifts of a minimum $1\frac{3}{4}$ inch binder course and $1\frac{1}{4}$ inch surface course.

(e) The bituminous mix design laboratory sheet shall be submitted with the plans and specifications.

(f) Aggregates in the binder course shall conform to the gradation requirements for gradation No. 2. Aggregates in the surface course shall conform to the gradation requirements for gradation No. 3. in accordance with sec. 304.2.6., WDOT standards for road and bridge construction.

(g) The asphalt shall meet the 120−150 penetration grade in accordance with AASHTO T49.

Note: Copies of AASHTO T49 may be inspected at the offices of the department, the secretary of state and the legislative reference bureau.

(h) The design mix of asphalt cement and aggregates shall yield a Marshall stability of no less than 1000 with an air void of the compacted mixture no more than 2%.

(i) The binder course shall be compacted to at least 93% 50 blow Marshall. The surface course shall be compacted to at least 95% 50 blow Marshall.

(j) The surface course shall be applied such that a minimum 2 foot overlap is to be provided over the binder course joints.

(k) Curbing or side walls shall be provided at the perimeter of the base and be sealed to prevent exfiltration at the seams and undercutting by rainfall. Dumping pads shall be paved and contiguous with the structure.

(L) A qualified inspector shall be on site during construction to document compaction measurements. Compaction shall be measured with a nuclear density meter, or other approved method.

Note: The department believes that properly mixed and applied bituminous concrete is a suitable construction material for by−product stacking structures. However, since longer−term studies have not yet been performed, the long−term performance of this material with this particular use cannot be predicted at this time.

Note: Copies of WDOT standard 304.2.6 may be inspected at the offices of the department, the secretary of state and the legislative reference bureau.

(5) CONCRETE STRUCTURE DESIGN AND CONSTRUCTION CRITERIA. (a) The pavement structure shall consist of a minimum of 10 inches of well drained soil subgrade or subbase. A suitable subgrade is one with 35% or less passing a No. 200 sieve and a plasticity index of 10 or less. The base course shall contain a minimum 4 inches of crushed aggregate and the surface course shall be 6 inches of concrete.

(b) Curbing or side walls shall surround the base and be sealed to prevent exfiltration at the seams and undercutting by rainfall. Dumping areas shall be paved and contiguous with the structure.

(c) The surface course curbing and walls shall be protected from chemical and biological decomposition with an appropriate sealant which is resistant to degradation from sunlight.

(d) The aggregates of the base course shall conform to the gradation requirements for gradation no. 2 in accordance with sec. 304.2.6, WDOT standards for road and bridge construction.

(e) Coarse aggregates of the concrete mixture shall be well graded between the limits specified in size no. 1 gradation in

accordance with sec. 501.3.6.4.5 WDOT standards for road and bridge construction.

(f) The concrete shall meet the mix grade A air−entrained concrete classification and a water to cement ratio of no greater than 0.45 with 6% air plus or minus 1%.

(g) Metal reinforcing rods or mesh shall be provided in the pavement structure.

(h) Contraction joints shall be placed no greater than 20 feet apart in all directions.

(i) Contraction and construction joints shall be sealed with appropriate caulk or sealant to prevent leakage. The proposed sealant shall be specified in the plans and specifications.

Note: Copies of WDOT standards 304.2.6 and 501.3.6.4.5 may be inspected at the offices of the department, the secretary of state and the legislative reference bureau.

(6) ANNUAL INSPECTION AND MAINTENANCE. All visible cracks shall be cleaned and sealed. A report summarizing the inspection and maintenance performed to the by−product solids stack structure shall be prepared and submitted to the department in accordance with the WPDES permit. An operation and maintenance plan shall also be included in the plans and specifications.

(7) LEACHATE COLLECTION SYSTEMS. (a) Design and construction criteria for a leachate collection system, consisting of conveyance and storage, shall be included with the plans and specifications. The system shall be totally contained and constructed in accordance with subch. II or s. NR 213.15.

(b) The leachate storage structure shall be sized to provide adequate capacity to store the leachate generated between disposal events and normal rainfall as well as the larger volume generated by a 10−year, 24 hour rainfall event. The length of time between disposal events shall be specified in the management plan required in ch. NR 214, and shall take into account such factors as availability of labor, leachate disposal equipment, and availability of leachate disposal sites.

(8) SURFACE WATER RUNOFF DIVERSION STRUCTURES. A surface water runoff diversion system shall be provided in the storage structure design.

History: Cr. Register, June, 1990, No. 414, eff. 7−1−90.

NR 213.15 Storage tanks. Storage tanks shall be designed, installed and maintained to prevent leaks due to corrosion or structural failure.

(1) Underground storage tanks shall be designed such that:

(a) They are cathodically protected against corrosion, constructed of noncorrosive material, constructed of coated steel with noncorrosive material or its equivalent.

(b) The materials of the tank or liner are compatible with the stored substance.

(c) An inspection manhole, vent and high water alarm are provided.

(d) Periodic testing shall be performed, such as pressure testing, to ensure the integrity of the tank is maintained.

(2) Above−ground storage tanks shall be designed such that:

(a) They are constructed of noncorrosive material, steel lined with noncorrosive material, or its equivalent.

(b) The materials of the tank or liner are compatible with the stored substance.

(c) An inspection manhole, vent and high water alarm are provided.

(d) The department may require a containment dike around storage tanks in locations where water pollution would potentially be caused by a spill or overflow.

History: Cr. Register, June, 1990, No. 414, eff. 7−1−90.

Chapter NR 243

ANIMAL FEEDING OPERATIONS

Note: Ch. NR 243 as it existed on June 30, 2007 was repealed and a new Ch. NR 243 was created, Register April 2007 No. 616, eff. 7−1−07.

Subchapter I — General

NR 243.01 Purpose. (1) The purpose of this chapter is to implement design standards and accepted management practices and to establish permit requirements and the basis for issuing permits to CAFOs. This chapter also establishes the criteria under which the department may issue a notice of discharge or a permit to other animal feeding operations that discharge pollutants to waters of the state or fail to comply with applicable performance standards and prohibitions in ch. NR 151. For other animal feeding operations, it is the intent of the department that a permit would be issued only when it can be demonstrated that an operation has a discharge of pollutants to waters of the state. The authority for promulgation of this chapter is in chs. 281 and 283, Stats.

(2) The department recognizes the unique nature of the state's agricultural industry and the industry's declared interest in protecting and preserving the state's natural resources. The department also recognizes the benefit of manure applied to land for its fertilizer and soil conditioning value, and encourages the management and use of these materials in such a manner. Only those animal feeding operations that improperly manage their wastes and as a result cause groundwater or surface water pollution or that fail to comply with applicable performance standards and prohibitions or those operations that are CAFOs will be regulated under this chapter. It is not the intent of the department to require that all animal feeding operations obtain a permit.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.02 Applicability. The provisions of this chapter are applicable to large CAFOs and other animal feeding operations that discharge pollutants to waters of the state as determined under subch. III.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.03 Definitions. The following definitions are applicable to terms used in this chapter. Definitions of other terms and meanings of abbreviations are in ch. NR 205.

(1) "Accepted management practices" means practices, techniques or measures through which runoff, manure, milking center waste, leachate and other waste streams associated with an animal feeding operation are handled, stored, utilized or otherwise controlled in a manner that is intended to achieve compliance with livestock performance standards and prohibitions established in ch. NR 151 and water quality objectives established under chs. 281 and 283, Stats. These practices, techniques or measures are established in this chapter as well as ch. NR 154 and ch. ATCP 50 and may include additional practices and procedures as approved by the department on a case−by−case basis.

(2) "Agricultural storm water discharge" means:

(a) For unpermitted animal feeding operations with 300 to 999 animal units, a precipitation−related discharge of manure or process wastewater pollutants to surface waters from a land application area that may occur after the owner or operator of the animal feeding operation has land applied manure or process wastewater in compliance with a nutrient management plan that meets the nutrient management requirements of this chapter; and

(b) For permitted CAFOs, a precipitation related discharge of manure or process wastewater pollutants to surface waters from a land application area that may occur after the owner or operator of the CAFO has land applied the manure or process wastewater in compliance with the nutrient management requirements of this chapter and the terms and conditions of its WPDES permit.

Note: The definition of agricultural storm water discharge does not include discharges of manure or process wastewater pollutants to surface waters from land application activities by an unpermitted small animal feeding operation, because these land application discharges to surface waters by a small operation are not a basis for requiring WPDES permit coverage. See s. NR 243.26 (2) (c).

(3) "Ancillary service and storage areas" means areas that are adjacent to the production area, but are not used for handling or managing livestock, livestock products, mortalities, manure, process wastewater or raw materials. These ancillary areas include areas such as access roads, shipping and receiving areas, pesticide and herbicide storage, oil or fuel storage, raw material handling equipment maintenance, crop equipment or vehicle storage and maintenance areas and refuse piles.

(4) "Animal feeding operation" means a lot or facility, other than a pasture or grazing area, where animals have been, are or will be stabled or confined, and will be fed or maintained for a total of 45 days or more in any 12−month period. Two or more animal feeding operations under common ownership or common management are a single operation if at least one of the following is true:

(a) The operations are adjacent.

(b) The operations utilize common systems for the landspreading of manure or other wastes, including a nutrient management plan or landspreading acreage.

Note: While it is not the sole factor used to determine whether operations have a common system for landspreading, use of common land application equipment is one of the factors the department considers when determining if operations have a common system for landspreading.

(c) Manure, barnyard runoff or other wastes are commingled in a common storage facility prior to landspreading.

(5) "Animal unit" means a unit of measure used to determine the total number of single animal types or combination of animal types, as specified in s. NR 243.11, that are at an animal feeding operation.

(6) "Applicant" means an owner or operator of a proposed or existing CAFO that is applying for a WPDES permit.

(7) "Areas of channelized flow" means channels or depressions that concentrate flow and are either:

(a) Man−made by a means other than typical field cultivation practices.

(b) A natural channel or depression that cannot be removed or rerouted using typical field cultivation practices or that form on a recurring basis in the same area.

(8) "ASTM" means the American society for testing and materials.

(9) "Combined animal units" means any combination of animal types calculated by adding the number of single animal types as multiplied by the equivalency factors as specified in s. NR 243.11.

(10) "Compost" has the meaning specified under s. NR 500.03 (44).

(11) "Composting" has the meaning specified under s. NR 500.03 (45).

(12) "Concentrated animal feeding operation" or "CAFO" means an animal feeding operation to which any of the following apply:

(a) The operation has 1,000 animal units or more at any time and stores manure or process wastewater in a below or at grade level storage structure or land applies manure or process wastewater.

(b) The operation has 300 to 999 animal units and has a category I unacceptable practice under s. NR 243.24 (1) (a).

(c) Under s. NR 243.26 (2), the operation is designated by the department as having a significant discharge of pollutants to navigable waters or has caused the fecal contamination of water in a well.

(13) "CAFO outdoor vegetated area" means an area that is part of the ancillary service and storage area that consists of a large open outdoor vegetated area of land used by CAFO animals that is owned or operated by a CAFO and is adjacent or connected to, but not part of, the production area.

(14) "Conduit to a navigable water" means a natural or man−made area or structure that discharges to a navigable water via channelized flow. This includes open tile line intake structures, open vent pipes, sinkholes, agricultural well heads, drainage ditches that discharge to navigable waters and grassed waterways that drain directly to a navigable water.

Note: Conduits to navigable waters do not include the components of a subsurface drainage system that are not present at the soil surface.

(15) "Contaminated runoff" means that portion of manure, process wastewater, leachate or other wastes or raw materials mixed with precipitation from animal feeding operations that transports pollutants such as organic matter, suspended solids or nutrients.

(16) "Corrective measures" means accepted management practices or technical standards specified in ch. NR 154 or ATCP 50 designed to address an unacceptable practice or other practices determined by the department to be necessary to protect water quality.

(17) "DATCP" means the Wisconsin department of agriculture, trade and consumer protection.

(18) "Department" means the Wisconsin department of natural resources.

(19) "Designed structures" means groundwater monitoring systems, runoff control structures, permanent spray irrigation or other land application systems, manure, raw materials and waste storage facilities or other manure or waste transfer or treatment systems.

(20) "Direct conduits to groundwater" mean wells, sinkholes, swallets, fractured bedrock at the surface, mine shafts, non−metallic mines, tile inlets discharging to groundwater quarries, or depressional groundwater recharge areas over shallow fractured bedrock.

(21) "Diversion" means a structure built to divert sheet flow or part or all of the water from an existing waterway into a different channel or area.

(22) "Exceptional resource water" means any surface water, or portion thereof, in s. NR 102.11.

(23) "Existing source CAFO" means an operation that is covered by a WPDES permit as of July 1, 2007, and any other permitted operation that is not a new source CAFO.

Note: Existing source CAFOs include CAFOs that are permitted as of July 1, 2007, and animal feeding operations in existence on a site prior to April 14, 2003 that add animals and later apply for a WPDES permit.

(24) "Frozen ground" means soil that is frozen anywhere between the first ½" and 8" of soil as measured from the ground surface.

Note: Under the definition of frozen ground, soil that is that frozen to a depth of ½" or less as measured from the ground surface is not considered frozen ground.

(25) "Governmental unit" means a municipality as defined in s. 281.01 (6), Stats.

(26) "Grassed waterway" means a natural or constructed waterway or outlet shaped or graded and established in suitable vegetation as needed for the conveyance of runoff from a field, diversion or other structure.

(27) "Hydrologic soil group" means a group of soils having similar runoff potential under similar storm and cover conditions.

(28) "Incorporation" means mixing the manure or process wastewater with surface soil so that at least 80% of applied manure or process wastewater is covered with soil and the application rate is controlled to ensure that applied material stays in place and does not run off. Incorporation includes standard agricultural practices such as tillage or other practices that are the equivalent to providing 80% soil coverage.

(29) "Injection" means the placement of liquid manure or process wastewater 4 to 12 inches below the soil surface in the crop root zone using equipment specifically designed for that purpose and where the applied material is retained by the soil and does not concentrate or pool below the soil surface.

(30) "Land application" means surface application, injection or incorporation of manure, process wastewater or other waste generated by a CAFO on cropland using manure hauling vehicles or equipment.

(31) "Large CAFO" means an animal feeding operation that has 1,000 animal units or more at any time.

(32) "Liquid manure" means manure with a solids content of less than 12%.

(33) "Livestock facility" means a structure or system constructed or established on a livestock operation or animal feeding operation, including a runoff control system associated with an outside feedlot, manure storage facility or feed bunker.

(34) "Livestock performance standards and prohibitions" means performance standards and prohibitions contained in ss. NR 151.05, 151.06, 151.07 and 151.08.

(35) "Long−term no−till" means no−till farming that has been implemented a minimum of 3 consecutive years.

(36) "Manure" means a material that consists primarily of litter or excreta, treated or untreated, from livestock, poultry or other animals. Manure includes material mixed with runoff, bedding contaminated with litter or excreta, or process wastewater.

(37) "Margin of safety level" means the level in a liquid storage or containment facility that is vertically one foot below the lowest point of the top of the facility or structure.

(38) "Maximum operating level" means the level in a liquid storage or containment facility, measured vertically from the lowest point of top of the facility, that is the sum of the margin of safety level and the level necessary to contain the precipitation and runoff that will enter the facility as a result of 100−year, 24−hour rainfall event for swine, veal and poultry operations that are new source CAFOs or a 25−year, 24−hour storm event for all other operations.

(39) "Medium CAFO" means an animal feeding operation with 300 to 999 animal units that has a category I discharge to navigable waters under s. NR 243.24, or that is designated by the department as a CAFO under s. NR 243.26 (2).

(40) "Milking center waste" means all wastes generated at a milking center or milkhouse including waste milk, detergents, acids, sanitizers, manure, bedding materials and footbath chemicals.

(41) "New source CAFO" means any of the following:

(a) An operation that is a large CAFO that has been or will be constructed on or after April 14, 2003, on a new site where no other animal feeding operation is located.

(b) An operation that is a large CAFO that was in existence prior to April 14, 2003, but that completely replaces all of its production or processing equipment on or after April 14, 2003.

(c) A new addition to an existing operation that is a large CAFO that is essentially a new production area added on or after April 14, 2003 that is completely independent of the production area in existence on the site before April 14, 2003.

(d) An animal feeding operation that has been constructed on or after April 14, 2003, on a new site where no other animal feeding operation is located and later becomes a large CAFO.

Note: New operations are operations that essentially build on a brand new site or significantly modify most or all facilities at an existing site, on or after April 14, 2003.

(42) "NOD" means notice of discharge.

(43) "NRCS" means the Wisconsin natural resources conservation service.

(44) "NRCS Standard 590" means the technical standard for nutrient management contained in Appendix B to ch. ATCP 51, except for section V.D.

Note: Appendix B to ch. ATCP 51 includes the September 2005 version of NRCS Standard 590.

(45) "100−year, 24−hour rainfall event" means a rainfall event measured in terms of the depth of rainfall occurring within a 24−hour period and having an expected recurrence interval of once in 100 years as identified in Table 1.

(46) "Outstanding resource water" means any surface water, or portion thereof, specified in s. NR 102.10.

(47) "Pasture or grazing area" means an area where animals graze in large open areas, that is not adjacent to, or connected to, a CAFO production area, and where stocking densities, management systems and management of feed sources ensure that sufficient vegetative cover is maintained over the entire area at all times. A pasture or grazing area is not an animal feeding operation.

Note: Operations that have milking centers for animals on pasture or grazing areas are animal feeding operations since the milking center is considered to be an area of confinement.

Note: A CAFO may have multiple production areas located at different sites or farms, such as a main farm and satellite feedlots or farms.

(48) "Permanent runoff control systems" means constructions or devices installed to permanently contain, control, divert or retard surface runoff water.

(49) "Permit" means a WPDES permit for the discharge of pollutants issued by the department under ch. 283, Stats.

(50) "Permittee" means an owner or operator of a WPDES permitted CAFO.

(51) "Phosphorus index" means the method for assessing and minimizing phosphorus delivery to surface waters associated with manure or process wastewater applications referenced in section V.C.2. of NRCS Standard 590.

(52) "Phosphorus index value" means the value calculated using the phosphorus index that identifies the relative level of risk for phosphorus delivery from a field where manure or process wastewater, along with other nutrients sources, have been or will be applied.

(53) "Process wastewater" means wastewater from the production area directly or indirectly used in the operation of animal feeding operation that results from any or all of the following:

(a) Spillage or overflow from animal or poultry watering systems.

(b) Washing, cleaning, or flushing pens, barns, manure pits, or other animal feeding operation facilities.

(c) Direct contact swimming, washing, or spray cooling of animals or dust control.

(d) Water that comes into contact with any raw materials or animal byproducts including manure, feed, milk, eggs or bedding.

(54) "Production area" means that part of an animal feeding operation that includes the animal confinement area, the manure storage area, the raw materials storage area, and the waste containment areas but not CAFO outdoor vegetated areas. The animal confinement area includes but is not limited to open lots, housed lots, feedlots, confinement houses, stall barns, free stall barns, milkrooms, milking centers, cowyards, barnyards, medication pens, walkers, animal walkways and stables. The manure storage area includes but is not limited to lagoons, runoff ponds, storage sheds, stockpiles, under house or pit storages, liquid impoundments, static piles, and composting piles. The raw materials storage area includes but is not limited to feed silos, silage bunkers and bedding materials. The waste containment area includes but is not limited to settling basins, and areas within berms and diversions that separate uncontaminated storm water. Included in the definition of production area is any egg washing or egg processing facility, and any area used in the storage, handling, treatment or disposal of mortalities.

(55) "Raw materials" means materials typically stored at an agricultural operation that are directly used in livestock production such as bedding material, silage, haylage, grain and other feed sources, but this term does not include pesticides, motor oil or fuel.

(56) "Reviewable facility or system" means runoff control structures, feed and other raw materials storage, permanent spray irrigation or other land application systems, groundwater monitoring systems, manure storage facilities, manure treatment or transfer systems, or other structures or systems associated with the storage, containment, treatment or handling of manure or process wastewater.

(57) "Saturated soils" means soils where all pore spaces are occupied by water and where any additional inputs of water or liquid wastes cannot infiltrate into the soil.

(58) "Solid manure" means manure with a solids content of 12% or more.

(59) "Small CAFO" means an animal feeding operation with less than 300 animal units that is designated by the department as a CAFO under s. NR 243.26 (2).

(60) "Snow covered ground" means areas of a field covered with any amount of snow.

(61) "Source water protection area" means an area delineated by the department for a public water system or including numerous public water systems, whether the source is ground water or surface water or both, as part of the state source water assessment program approved by the U.S. environmental protection agency under 42 USC 300j−13.

(62) "Spray irrigation" means the application of liquid manure or process wastewater to cropland using equipment that discharges manure into the air via a single nozzle or multiple nozzles or hoses and disperses the manure over distances greater than could be achieved using typical moving vehicle or manure hauling equipment.

(63) "Storage facility" means an excavated or diked pond, walled structure or platform designed for containment of manure.

(64) "Sufficient vegetative cover" means that crop residue or vegetation is present over an entire area in an amount and density of stand that slows the movement of and limits contaminated runoff and soil erosion.

(65) "Surface applied manure" means manure applied to the ground surface by moving vehicles that is not incorporated or injected.

(66) "Surface water quality management areas" or "SWQMA" means all of the following:

(a) The area within 1,000 feet from the ordinary high water mark of navigable waters that consist of a lake, pond or flowage.

(b) The area within 1,000 feet from the high water mark of navigable waters that consist of a glacial pothole lake.

(c) The area within 300 feet from the ordinary high water mark of navigable waters that consist of a river or stream or other non−lake navigable waters.

(d) The area within 300 feet of conduits to navigable waters.

(67) "Swallet" means a sinkhole or rock hole that intercepts a stream, diverting all or a portion of it to groundwater.

(68) "303 (d) listed waters" means the list of impaired waters in the state developed by the department pursuant to 33 USC 1313 and 40 CFR 130.7.

(69) "Tolerable soil loss" or "T" means the maximum rate of soil erosion, in tons per acre per year, allowable for particular soils and site conditions that will maintain soil productivity.

Note: Soil loss will be calculated according to the revised universal soil loss equation II as referenced in ch. ATCP 50 or, potentially, SNAP−Plus software currently being developed by UW−Extension.

(70) "25−year, 24−hour rainfall event" means a rainfall event measured in terms of the depth of rainfall occurring within a 24−hour period and having an expected recurrence interval of once in 25 years as identified in Table 1.

(71) "Unacceptable practice" means a practice that causes or has caused the discharge of pollutants to waters of the state or that results in an operation's failure to comply with livestock performance standards and prohibitions outlined in ch. NR 151.

(72) "Wastewater treatment strip" means a constructed strip or area of vegetation for reducing sediment, organic matter and other pollutants.

(73) "Waters of the state" has the meaning specified under s. 283.01 (20), Stats.

(74) "Water quality management area" or "WQMA" has the meaning in s. NR 151.015 (24).

(75) "Wetland" means areas delineated on a hydric soils map that are dominated by hydrophytic vegetation. Wetlands do not include prior converted or farmed wetlands.

(76) "Wetland functional values" means the values or uses of wetlands established in s. NR 103.03 (1).

(77) "Wet soil" means soil that is not saturated but has a moisture content that limits its ability to absorb significant amounts of additional liquid.

(78) "Winter acute loss index value" means the value calculated using the phosphorus index that identifies the relative level of risk for acute losses of manure and process wastewater pollutants associated with surface applications during frozen or snow−covered conditions.

(79) "WPDES" means the Wisconsin pollutant discharge elimination system established under ch. 283, Stats.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.04 Rainfall events. The design rainfall amount and probable intensity of 25−year, 24−hour and 100−year, 24−hour rainfall events for locations in Wisconsin shall be determined from the data in Table 1, or for a particular location, the determination may be made on the basis of more recent rainfall probability data verified by a government agency and approved by the department for this purpose.

TABLE 1
Probable 25−year and 100−year 24−Hour Rainfall Events, In Inches of Rain, for Counties in Wisconsin

	25−year	100−year		25−year	100−year
Adams	4.7	5.9	Marathon	4.5	5.7
Ashland	4.3	5.4	Marinette	4.1	4.9
Barron	4.6	5.8	Marquette	4.6	5.8
Bayfield	4.4	5.4	Menominee	4.3	5.2
Brown	4.3	5.1	Milwaukee	4.5	5.5
Buffalo	4.8	6.1	Monroe	4.8	6.1
Burnett	4.6	5.7	Oconto	4.2	5.1
Calumet	4.4	5.3	Oneida	4.3	5.3
Chippewa	4.7	5.8	Outagamie	4.4	5.3
Clark	4.7	5.9	Ozaukee	4.4	5.4
Columbia	4.7	5.9	Pepin	4.8	6.0
Crawford	5.0	6.2	Pierce	4.8	6.0
Dane	4.8	6.0	Polk	4.7	5.8
Dodge	4.6	5.7	Portage	4.5	5.7
Door	4.1	4.9	Price	4.4	5.5
Douglas	4.4	5.5	Racine	4.6	5.6
Dunn	4.7	6.0	Richland	4.9	6.2
Eau Claire	4.7	6.0	Rock	4.7	6.0
Florence	4.1	4.9	Rusk	4.6	5.7
Fond du Lac	4.5	5.6	St. Croix	4.7	5.9
Forest	4.2	5.1	Sauk	4.8	6.1
Grant	5.0	6.2	Sawyer	4.5	5.6
Green	4.8	6.1	Shawano	4.4	5.4
Green Lake	4.6	5.7	Sheboygan	4.4	5.4
Iowa	4.9	6.2	Taylor	4.6	5.7
Iron	4.3	5.3	Trempealeau	4.8	6.1
Jackson	4.8	6.0	Vernon	4.9	6.2
Jefferson	4.6	5.8	Vilas	4.3	5.2
Juneau	4.7	6.0	Walworth	4.6	5.8
Kenosha	4.6	5.7	Washburn	4.5	5.6
Kewaunee	4.2	5.0	Washington	4.5	5.5
LaCrosse	4.9	6.1	Waukesha	4.6	5.6
Lafayette	4.9	6.2	Waupaca	4.5	5.5
Langlade	4.3	5.3	Waushara	4.6	5.7
Lincoln	4.4	5.5	Winnebago	4.5	5.5
Manitowoc	4.3	5.2	Wood	4.6	5.8

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.05 Calculating animal units. (1) GENERAL. The total number of animal units at an operation shall be calculated using the methods in both subs. (2) and (3). The department shall compare the totals under both of these methods and shall use the highest calculated total to determine the size of an animal feeding operation. An owner or operator of an animal feeding operation shall use form 3400−25A for calculating the number of animal units present at the operation.

Note: In accordance with the definition in s. NR 243.03(4), animals included in the total count may be housed at more than one site or location.

Note: Form 3400−25A can be obtained at regional offices of the department or the department's Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, Wisconsin 53707.

(2) COMBINED ANIMAL UNITS. The number of animal units present at an operation shall be calculated by multiplying the number of animals for each animal type by the appropriate equivalency factor in Table 2A. The total number of animal units at the operation is the sum of the calculated animal unit numbers of all animal types present at the operation.

Note: Under the combined animal unit calculation, an operation with 400 animal units of milking cows, 300 animal units of heifers and 200 animal units of swine would have a total of 1000 animal units present.

(3) INDIVIDUAL ANIMAL UNITS. The number of animal units present at an operation shall be calculated by multiplying the num-

ber of animals for each animal type by the appropriate equivalency factor in Table 2B. The total number of animal units at an operation is the highest calculated number of animal units for any individual animal type.

Note: Under the individual animal unit calculation, an operation with 400 animal units of milking cows, 300 animal units of heifers and 200 animal units of swine would have 400 animal units present.

(4) OTHER ANIMAL TYPES. For animal types not listed in Table 2A, the department shall base equivalency to animal units on live animal weights, the characteristics of the manure, including nutrient content or pollutant concentration, or a combination of both. In cases based strictly on live weight, 1,000 pounds of live weight is equivalent to one animal unit.

TABLE 2A
Combined Animal Unit Calculation Equivalencies

Animal Type	Combined Animal Equivalent of 1,000 Animal Units	Combined Animal Unit Equivalency Factor
Dairy Cattle:		
Milking and Dry Cows	715	1.4
Heifers (800 to 1200 lbs)	910	1.1
Heifers (400 to 800 lbs)	1670	0.6
Calves (under 400 lbs)	5000	0.2
Veal Calves:		
Per Animal	2000	0.5
Beef Cattle:		
Steers or Cows (400 lbs to Mkt)	1000	1.0
Calves (under 400 lbs)	5000	0.2
Bulls	700	1.4
Swine:		
Pigs (55 lbs to Mkt)	2500	0.4
Pigs (up to 55 lbs)	10000	0.1
Sows	2500	0.4
Boars	2000	0.5
Sheep:		
Per Animal	10000	0.1
Horses:		
Per Animal	500	2.0
Ducks:		
Per Bird (Liquid poultry manure handling)	5000	0.2
Per Bird (Non−liquid poultry manure handling)	100000	0.01
Chickens:		
Per Bird (Liquid poultry manure handling)	3000	0.033
Layers (Non−liquid poultry manure handling)	10000	0.01
Broilers and Pullets (Non−liquid poultry manure handling)	200000	0.005
Turkeys:		
Per Bird	55000	0.018

TABLE 2B
Individual Animal Unit Calculation Equivalencies

Animal Type	Individual Animal Equivalent of 1,000 Animal Units	Individual Animal Unit Equivalency Factor
Dairy Cattle:		
Milking and Dry Cows	700	1.43
Heifers (400 to 1200 lbs)	1000	1.0
Veal Calves:		
Per Animal	1000	1.0
Beef Cattle:		
Steers, Bulls or Cows (400 lbs to Mkt)	1000	1.0
Swine:		
Pigs (55 lbs to Mkt)	2500	0.4
Pigs (up to 55 lbs)	10000	0.1
Sheep:		
Per Animal	10000	0.1
Horses:		
Per Animal	500	2.0
Ducks:		
Per Bird (Liquid poultry manure handling)	5000	0.2
Per Bird (Non−liquid poultry manure handling)	30000	0.0333
Chickens:		
Per Bird (Liquid poultry manure handling)	30000	0.0333
Layers (Non−liquid poultry manure handling)	82000	0.0123
Broilers and Pullets (Non−liquid poultry manure handling)	125000	0.008
Turkeys:		
Per Bird	55000	0.018

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.06 Variances. (1) A permittee may request a waiver or variance to a requirement of this chapter. Subject to sub. (2), the department may approve a variance from a requirement in this chapter when special circumstances show that a variance is needed and the approval of the variance will not negatively impact or threaten the environment or public health. A request for a variance shall be submitted in writing and shall specify the requirement in this chapter from which a variance is requested and the reasons a variance is needed. The department shall approve or deny the variance within 30 days after the request is submitted.

(2) The department may not grant a waiver or variance to a federal statutory or regulatory requirement or to a state statutory requirement.

Note: If a permittee seeks approval of a variance to a requirement from this chapter that is specified in a WPDES permit, the permit must be modified to include the approved variance. Consequently, permittees should consider submitting any variance requests as part of the permit application process, so if approved, the variance can be incorporated into the permit.

Note: An animal feeding operation may participate in the Environmental Results Program (also known as the Green Tier Program) pursuant to s. 299.83, Stats. For

more information on this innovative program that provides regulatory flexibility and superior environmental results, please contact the department at 608−267−3125.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.07 Incorporation by reference. (1) CODE OF FEDERAL REGULATIONS. 40 CFR 412.22 in effect as of July 1, 2007, is incorporated by reference for this chapter. This federal regulation references 40 CFR 125.30 through 125.32 and these federal regulations are also incorporated by reference for this chapter. Copies of these regulations are available for inspection at the offices of the department and the legislative reference bureau, Madison, Wisconsin.

Note: Copies of these materials may be also be viewed online at www.gpo.gov, or may be purchased for personal use from: Superintendent of Documents, U.S. Government Printing Office, PO Box 371954, Pittsburgh, PA 15250−7954, phone: (202) 783−3238.

(2) OTHER MATERIALS. The materials listed in this section are incorporated by reference for this chapter. Some of the technical standards include secondary materials which are also incorporated by reference for this chapter. Copies of these materials are available for inspection at the offices of the department and the legislative reference bureau, Madison, Wisconsin. The materials incorporated by reference include:

(a) NRCS Standard 313, dated December 2005. NRCS Standard 313, dated December 2005, includes all of the following materials:

1. NRCS Agricultural Waste Management Field Handbook, Part 651, chs. 9 and 10, 1992.

2. NRCS Standard 342, dated June 2002.

3. NRCS Construction Specification 4, dated September 2003.

4. NRCS Construction Specification 203, dated March 2005.

5. NRCS Construction Specification 204, dated March 2005.

6. NRCS Construction Specification 300, dated December 2005.

7. American Concrete Institute 318, Building Code Requirements for Reinforced Concrete, in effect as of July 1, 2007.

8. ASTM Standard D−653−05.

9. ASTM Standard D−2488−00.

10. ASCE Standard SEI/ASCE 7−02.

11. ASAE Standard EP378.3.

12. ASAE Standard EP393.2.

(b) NRCS Standard 332, dated May 2002.

(c) NRCS Standard 360, dated December 2002.

(d) NRCS Standard 393, dated January 2001.

(e) NRCS Standard 585, dated June 2002.

(f) NRCS Standard 634, dated December 2005. NRCS Standard 634, dated December 2005, includes all of the following materials:

1. NRCS Construction Specification 15, Plastic Pipe Conduits, dated January 2006.

2. NRCS Standard 430DD−1, dated December 1988.

(g) NRCS Standard 635, dated January 2002. NRCS Standard 635, dated January 2002, includes all of the following materials:

1. NRCS Standard 350, dated July 2002.

2. NRCS Standard 612, dated March 2003.

Note: Copies of NRCS technical standards may be inspected at offices of the department, DATCP, NRCS (http://www.wi.nrcs.usda.gov), county land conservation departments and legislative reference bureau, Madison, Wisconsin.

Note: Copies of ASTM Standards may be obtained online at www.astm.org or at the corresponding address: American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428−2959.

Note: Copies of ASCE Standards may be obtained from the American Society of Civil Engineers online at http://www.asce.org.

Note: Copies of ASAE Standards may be obtained from the American Society of Agricultural and Biological Engineers online at http://www.asabe.org.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07; corrections in (1) and (2) (intro.) made under s. 13.92 (4) (b) 6., Stats., Register April 2013 No. 688.

Subchapter II — Requirements for Large Concentrated Animal Feeding Operations

NR 243.11 Large concentrated feeding operations. (1) APPLICABILITY. The provisions of this subchapter are applicable to existing large CAFOs, proposed expansions of existing animal feeding operations that will become large CAFOs and newly proposed large CAFOs.

Note: Owners or operators of animal feeding operations are responsible for obtaining all necessary state and local permits and approvals in addition to those outlined in this subchapter.

(2) CALCULATION OF ANIMAL UNITS. The determination as to whether an existing, proposed or expanded operation meets the criteria of a large CAFO shall be based on the total number of animal units at the animal feeding operation calculated pursuant to s. NR 243.05. Based on the provisions of this subchapter and information provided as part of an operation's application for a WPDES permit, as required in s. NR 243.12, the department shall determine whether a WPDES permit is required for an operation.

(3) WPDES PERMIT COVERAGE REQUIRED. (a) Except as provided in par. (b), any person owning or operating a large CAFO that stores manure or process wastewater in a structure that is at or below grade or that land applies manure or process wastewater shall have a WPDES permit. A discharge of pollutants from manure or process wastewater to waters of the state by an unpermitted animal feeding operation with 1,000 animal units or more is prohibited. A pasture or grazing area may operate without WPDES permit coverage.

(b) If a person owns or operates an animal feeding operation with 999 animal units or less, and that person expands its operation to 1000 animal units or more due to the purchase of another animal feeding operation, that person has 90 days from the date of the purchase to apply for a WPDES permit.

(4) ADDITIONAL INFORMATION. If requested by the department, owners or operators of animal feeding operations indicating that their operation will have 900 animal units or more shall submit additional information to the department regarding how the estimated number of animal units was calculated in accordance with Table 2A and 2B.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.12 WPDES permit application requirements. (1) GENERAL. A large CAFO may not discharge pollutants from manure or process wastewater to waters of the state unless the discharge is covered by and in compliance with a WPDES permit. Pursuant to s. 283.37 (2), Stats., a complete application for a WPDES permit shall be filed in accordance with the following requirements:

(a) Except as provided for in par. (c), a person who is proposing to own or operate a large CAFO that will store manure or process wastewater in a storage facility constructed at or below grade or that will land apply manure or process wastewater shall file a preliminary application for a WPDES permit at least 12 months prior to the intended date on which the operation will become a large CAFO. The preliminary application for a WPDES permit shall consist of completed forms 3400−25 and 3400−25A. The owner or operator shall then submit a completed final WPDES permit application under sub. (2) at least 180 days prior to the intended date on which the operation would become a large CAFO. The owner or operator of a proposed large CAFO may not discharge pollutants from manure or process wastewater to waters of the state until one of the following has occurred:

1. The department has issued an individual WPDES permit for the operation.

2. The department has granted general WPDES permit coverage to the operation under s. NR 243.121.

(b) An owner or operator of an operation that is defined as a large CAFO as of July 1, 2007, that is not already covered by a WPDES permit or that has not already submitted a WPDES permit

application, shall submit a complete permit application to the department by no later than July 31, 2007.

(c) An owner or operator of an animal feeding operation with 999 animal units or less that becomes a large CAFO as a result of the purchase of another animal feeding operation shall apply for a WPDES permit no later than 90 days from the date of the purchase.

Note: Owners or operators of an operation that has chickens or ducks with a non−liquid manure handling system, heifers, ducks or veal calves may become a CAFO for the first time due to the rule changes that became effective on July 1, 2007. Consequently, the department advises owners or operators to re−calculate the total number of animal units using the numbers in s. NR 243.05 and Table 2B to determine whether the operation has 1000 animal units or more and is required to obtain permit coverage.

(d) An owner or operator of a large CAFO that already holds a WPDES permit shall reapply at least 180 days prior to the expiration date of its current WPDES permit, unless all of the following apply:

1. The permittee has ceased operation or is no longer defined as a large CAFO under s. NR 243.03 (28).

2. The permittee has demonstrated to the department that there is no remaining potential for a discharge of manure or process wastewater pollutants to waters of the state that was generated while the operation was a CAFO.

3. The permittee submits a letter to the department documenting that subds. 1. and 2. have been satisfied.

Note: Due to the extent of water resources in the state, it is the department's position that if the manure or process wastewater from a CAFO is land applied to sites in Wisconsin, pollutants from the manure or process wastewater will reach waters of the state either via leaching to groundwater or surface runoff. Also, it is the department's position that storage facilities constructed at or below grade will have some pollutant discharges to groundwater. Therefore, all large CAFOs must apply for a WPDES permit.

(2) CONTENTS OF A FINAL PERMIT APPLICATION. (a) For a person applying for a first time permit issuance, a complete final permit application shall consist of the following:

1. The location of the existing or proposed site on maps including aerial photographs and soil survey maps.

2. A scaled drawing of existing and proposed animal housing, feed storage structures and other raw materials storage areas. The production area shall be clearly delineated as well as ancillary service and storage areas. Existing features shall be clearly delineated from proposed features.

3. A description and scaled drawing of existing and proposed manure storage or composting facilities, process wastewater storage or treatment facilities and other treatment systems. Plans and specifications for new manure storage or composting facilities and process wastewater facilities or proposed modifications to existing storage, composting or treatment facilities or systems shall be submitted. Upon approval by the department, plans and specifications for proposed storage, composting or treatment facilities may be submitted during the term of the permit if construction of the facilities will begin during the term of the permit. In addition, evaluations of existing storage, composting or treatment facilities or systems not previously reviewed and approved by the department shall be submitted.

Note: Stormwater construction site permit procedures and requirements outlined in ch. NR 216 may apply to construction activities.

4. A description and scaled drawing of existing and proposed runoff control systems, groundwater monitoring systems, water supply wells, permanent spray irrigation systems or other landspreading or treatment systems. Plans and specifications for new systems or proposed modifications to existing systems shall be submitted. Upon approval by the department, plans and specifications for proposed systems may be submitted during the term of the permit if construction of these facilities is planned to begin during the term of the permit. In addition, evaluations of existing systems not previously reviewed and approved by the department shall be submitted.

Note: Department approval to submit plans and specifications for proposed systems and evaluations of existing systems during the term of the permit does not delay compliance with the requirements in s. NR 243.13.

5. A description and scaled drawing of any existing and proposed ancillary service and storage areas and outside animal lots, including a map showing the area's size and location, the number of animals to be using the area, projected number of days in use, and type and percent of vegetative cover to be maintained.

6. A complete nutrient management plan that meets the requirements of s. NR 243.14. The plan shall be based on the volume of manure that will be generated by the operation from 1,000 animal units or the number of animal units that are expected to be at the operation by the end of the first year of permit coverage, whichever is greater. The permittee shall specify the expected number of animal units at the operation for the first year of the permit and during the permit term. The plan shall include all of the following information:

a. A narrative overview of the operation's nutrient management plan including a general description of anticipated amounts and types of manure and process wastewater produced on an annual basis, amount of manure and process wastewater to be land applied, anticipated frequency of land application for manure and process wastewater, methods of land application, and other methods of use, disposal, distribution or treatment.

b. Additional information the department requests for the purpose of identifying possible water quality impacts associated with an operation's land application activities.

7. Any other information requested by the department that is necessary to comply with the requirements of ch. NR 150.

Note: The department has developed an environmental analysis questionnaire identifying most of the information needed to comply with ch. NR 150 that is included as part of a large CAFO's application package for first time issuances.

(b) For operations submitting a reissuance application, a complete reissuance application shall consist of the following:

1. Information on changes to the operation that have occurred during the current permit term and changes that are anticipated during the upcoming permit term, including changes that are necessary to comply with this chapter.

2. The location of the existing site and proposed modifications to the site on maps such as aerial photographs and soil survey maps.

3. Scaled drawing and descriptions of existing and proposed animal housing, manure storage, composting and treatment facilities, process wastewater storage or treatment facilities or systems, runoff control structures or systems, feed storage structures, groundwater monitoring systems, water supply wells, ancillary and service storage areas, loafing and outside lot areas and feed storage structures. Existing features shall be clearly delineated from proposed features.

4. An updated nutrient management plan reflecting changes that have occurred at the operation since the previous permit issuance or reissuance and that incorporates the requirements in this chapter.

5. A description of permanent spray irrigation systems and any other landspreading or treatment systems.

6. Any other information requested by the department that is necessary to comply with the requirements of ch. NR 150.

(3) APPLICATION FORMS. Final permit and reissuance application information shall be submitted along with completed forms 3400−25 and 3400−25A. The department shall take action on a complete application pursuant to s. NR 200.10.

Note: Applications and forms 3400−25 and 3400−25A can be obtained at regional offices of the department or the department's Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, Wisconsin 53707.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.121 General permit coverage. (1) GENERAL PERMIT. (a) The department may issue a WPDES general permit to cover a category or group of CAFOs where the department has determined that the operations will not be covered by an individual permit issued pursuant to s. 283.37 (2), Stats.

(b) For purposes of this section, a category or group of CAFOs may be defined by size of operation, type of livestock or species, geographic or watershed area, method of managing manure or any other feature or attribute that the department determines is appropriate for defining a category of coverage.

(2) GENERAL PERMIT APPLICATION REQUIREMENTS. An owner or operator seeking coverage under a general permit shall submit an application to the department in accordance with s. NR 243.12 and shall include information documenting that the operation qualifies for the general permit based on the eligibility criteria specified in the general permit.

(3) GENERAL PERMIT ELIGIBILITY. The department shall specify criteria for determining eligibility for general permit coverage in the WPDES general permit.

(4) INDIVIDUAL PERMIT COVERAGE. Under s. 283.35 (3), Stats., the department may withdraw general permit coverage for a CAFO and issue an individual permit to the CAFO. The CAFO shall submit additional information requested by the department that is needed for issuance of an individual permit.

Note: The department may allow a permittee to participate in a cooperative compliance program to assist the CAFO with maintaining compliance with a general permit. A cooperative compliance program is an organization comprised of several CAFOs that have been granted permit coverage under a general permit. Cooperative compliance programs primarily assist facilities in maintaining compliance with general permits. Cooperative compliance programs retain environmental experts with substantial experience and knowledge in the management of manure and nutrients, design and maintenance of agricultural best management practices and environmental protection.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.13 Standard WDPES permit requirements for large CAFOs. (1) GENERAL. The department shall include conditions in permits that meet the requirements in subs. (2) to (8), if applicable to the primary livestock type housed at the CAFO. Pursuant to s. 283.31, Stats., the department shall include conditions in a WPDES permit for the production area and ancillary service and storage areas to ensure that clean water is diverted, as appropriate, from the production area and that are necessary to achieve compliance with surface water and groundwater quality standards contained in chs. NR 102 to 105, 140 and 207, and the livestock performance standards and prohibitions prescribed in ch. NR 151.

Note: Large CAFOs are not eligible for cost sharing under chs. NR 153 and 154, nor is cost sharing necessary for compliance with the livestock performance standards and prohibitions.

(2) DAIRY COWS, CATTLE AND DUCKS. (a) The standard in this subsection applies to large CAFOs that confine mostly mature dairy cows, milking or dry, or cattle such as heifers, steer or bulls, or ducks. Except as provided in par. (b) or (c), a large CAFO may not discharge manure or process wastewater pollutants to navigable waters from the production area, unless all of the following apply:

1. Precipitation causes an overflow of manure or process wastewater from a containment or storage structure.

2. The containment or storage structure is properly designed, constructed and maintained to contain all manure and process wastewater from the operation, including the runoff and the direct precipitation from a 25−year, 24−hour applicable rainfall event.

3. The production area is operated in accordance with the inspection, maintenance and record keeping requirements in s. NR 243.19.

Note: Operations are not allowed to discharge pollutants to navigable waters under any circumstance or storm event from areas of the production area where manure or process wastewater is not properly stored or contained by a structure. Wastewater treatment strips, grassed waterways or buffers are examples of facilities or systems that by themselves do not constitute a structure.

(b) 1. The department may establish an alternative discharge limitation to the standard limitation established in par. (a) if an applicant or permittee requests an alternative limitation. When requesting an alternative site specific limitation, the applicant or permittee shall submit all of the following additional information as part of the application for WPDES permit issuance or reissuance:

a. A technical analysis, calculations and other relevant information that demonstrates that the discharge of pollutants, on a mass basis, associated with the alternative limitation will be equal to or less than the mass loading of pollutants associated with achieving the standard limitations in par. (a).

b. A calculation of daily inputs to the storage systems and all daily outputs from the storage systems, including losses due to evaporation, sludge removal, and off−site transport of manure and wastewater.

c. A calculation determining the median annual overflow volume based on a 25−year period of actual rainfall data applicable to the site.

d. Representative samples and analysis of all sources of input into the storage systems for nitrogen, phosphorus, BOD_5 and total suspended solids, or other applicable pollutant data.

e. Predicted annual average discharge of pollutants, expressed, where appropriate, as a mass discharge on a daily basis in pounds per day, and calculated considering the information in this subd. 1. b. to d.

f. Any additional information requested by the department.

2. The department may approve an alternative limitation if the alternative limitation is based on site specific alternative technologies that will achieve a quantity of pollutants discharged from the production area that is equal to or less than the quantity of pollutants that would be discharged if the production area was designed, constructed, operated and maintained in compliance with the standard limitation in par. (a). If approved, the alternative limit shall be included in the proposed WPDES permit.

(c) A large CAFO that primarily confines ducks, was in existence as of 1974 and has not completely replaced all of its production or processing equipment after 1974, may have a discharge of pollutants from the production area to navigable waters that meets the limits in 40 CFR 412.22 provided the discharge will not exceed water quality standards. 40 CFR 412.22 is incorporated by reference in s. NR 243.07. The department shall impose best management practices or effluent limitations on the discharge to address other pollutants associated with manure or process wastewater or to meet surface water or groundwater quality standards. If the permittee chooses this option, the permittee shall monitor pollutants in all runoff from the production area to demonstrate compliance with effluent limitations.

Note: Copies of 40 CFR 412.22 and the other federal regulations referenced in 40 CFR 412.22 are available for inspection at the office of the department, Madison, Wisconsin and U.S. EPA offices.

(3) SWINE, POULTRY OTHER THAN DUCKS AND VEAL CALVES. (a) Except as provided in par. (b), a large CAFO that is an existing source CAFO that confines mostly swine, poultry other than ducks or veal calves shall comply with the requirements in sub. (2).

Note: All existing source dairy, cattle, swine, poultry other than ducks, and veal operations, are subject to the same discharge limitations related to the 25−year, 24−hour storm event as well as the same allowances for alternative discharge limitations. New source swine, poultry other than ducks, and veal calves have more restrictive discharge limitations and additional criteria for receiving alternative discharge limitations.

(b) A large CAFO that is a new source CAFO and that confines mostly swine, poultry other than ducks or veal calves may not discharge manure or process wastewater pollutants into navigable waters from the production area except as provided in par. (c). Storage and containment facilities and structures shall be designed, constructed, operated and maintained to contain all manure and process wastewater, including runoff and the direct precipitation from a 100−year, 24−hour rainfall event, and the production area shall be operated in accordance with the inspection, maintenance and recordkeeping requirements in s. NR 243.19.

(c) 1. For swine, poultry other than ducks or veal calf operations that are new source CAFOs, the department may establish

an alternative discharge limitation to the applicable standard limitation established in par. (b) if an owner or operator of the large CAFO requests an alternative limitation. When requesting an alternative limitation under this paragraph, the applicant shall submit all of the following additional information as part of the application for WPDES permit issuance:

a. Calculations that demonstrate that the quantity of pollutants discharged from the production area will be offset by additional best management practices that achieve an equivalent or greater reduction in the quantity of pollutants released to other media, including water and air, from the production area or land application areas. The calculations shall be made on a mass basis, where appropriate.

b. Any other specific information requested by the department that is needed by the department to make a determination pursuant to this paragraph.

2. If approved by the department, the alternative limitation shall be established in the WPDES permit and shall be based on site specific innovative technologies that will achieve an overall environmental performance across all media that is equal to, or superior to, the reductions achieved by the standard as provided in par. (b).

(4) HORSES AND SHEEP. (a) This subsection applies to large CAFOs that confine mostly horses or sheep. All large CAFOs that confine mostly horses or sheep may not discharge process wastewater pollutants into navigable waters from the production area except if both of the following are met:

1. A rainfall event causes an overflow of process wastewater from a facility or structure designed, constructed, operated and maintained to contain all process wastewater generated including the runoff from a 25−year, 24−hour rainfall event.

2. The discharge complies with water quality standards.

(b) In a WPDES permit, the department may impose additional requirements or best management practices, or other restrictions for production area discharges of manure or process wastewater to meet surface water quality or groundwater standards.

(5) ALL LARGE CAFOS. (a) If a discharge of manure or process wastewater pollutants to waters of the state occurs, including a discharge allowed under subs. (2) to (4), the discharge shall comply with groundwater and surface water quality standards.

(b) The permittee may not allow livestock to come into direct contact with navigable waters in the production area.

(6) EMERGENCY RESPONSE PLAN. (a) *General.* Within 30 days of permit issuance or reissuance, a permittee shall develop an emergency response plan, or update an existing plan if necessary, that is designed to address unauthorized spills or discharges. For purposes of this subsection, unauthorized spills or discharges include catastrophic spills resulting from failures of containment or storage structures or equipment malfunctions, leakage from pumping systems and other events creating potential environmental damage. The emergency response plan shall be maintained at the production area in a place accessible to all employees. The permittee shall notify all employees involved with manure handling of the location and contents of the emergency response plan. Relevant portions of the plan shall be retained with land application equipment and with contracted land applicators. The plan shall be implemented whenever an unauthorized spill or discharge occurs. The plan shall be made available to the department upon request.

Note: Pursuant to s. 292.11, Stats., owners or operators of CAFOs are required to report spills of hazardous substances. Under s. 292.11, Stats., manure can be considered a hazardous substance.

(b) *Plan content.* The emergency response plan shall include all of the following information:

1. The names and telephone numbers of persons who are identified by the permittee as responsible for implementing the emergency response plan.

2. Areas of the production area where potential unauthorized spills or discharges can occur, and their accompanying surface and subsurface drainage points.

3. Procedures to be followed in the event of an unauthorized spill or discharge, including the following:

a. Actions to contain, minimize and manage any unauthorized discharge.

b. Actions to mitigate the adverse effects of any unauthorized discharge.

c. Identification of contractors, equipment, equipment technical support, clean−up materials and alternative manure storage that can be used in the event of an unauthorized discharge.

d. Identification of land application sites or alternative storage facilities that can be used in the event of an unauthorized discharge during precipitation events or when soils are saturated, frozen or snow covered. Those land application sites identified shall have the lowest potential to deliver pollutants to waters of the state out of all the land application sites available to the permittee.

e. Procedures for reporting the unauthorized discharge to the permittee's main operational contact, any applicable local emergency or health authorities, and the department in accordance with permit requirements and s. 292.11, Stats.

(c) *Amendments.* The emergency response plan shall be reviewed and, if appropriate or necessary, amended whenever the operation undergoes significant expansions or other changes that affect the volume or location of potential unauthorized spills or discharges. The plan shall be amended as needed to reflect changes in available equipment, available clean−up contractors or procedures to address unauthorized spills or discharges, or amended in accordance with comments provided by the department. Dates of plan amendments shall be retained with the plan at the production area.

(7) ANCILLARY SERVICE AND STORAGE AREAS. In accordance with the terms and conditions of the WPDES permit, a permittee may discharge contaminated storm water to waters of the state from ancillary service and storage areas provided the discharges of contaminated stormwater comply with groundwater and surface water quality standards. These areas include CAFO outdoor vegetated areas, access roads, sites used for the handling or storage of material or refuse other than manure, bedding, feed or process wastewater, areas for storage or maintenance of material handling equipment, areas for shipping and receiving, and other sources of contamination that are not identified as part of the production area. These areas do not include land application areas. The permittee shall take preventive maintenance actions and conduct periodic visual inspections to minimize the discharge of pollutants from these areas to surface waters. For CAFO outdoor vegetated areas, the permittee shall also implement the following practices:

(a) Manage stocking densities, implement management systems and manage feed sources to ensure that sufficient vegetative cover is maintained over the entire area at all times.

(b) Prohibit direct access of livestock or poultry to surface waters or wetlands located in or adjacent to the area unless approved by the department.

(c) Comply with other measures specified in the permit to prevent exceedances of groundwater and surface water quality standards.

Note: Examples of ancillary service and storage areas include access roads into the production area, pesticide storage, motor oil and fuel drums, equipment repair areas, and junk or scrap piles. These areas do not include land application areas or areas that are part of the production area. Contaminated stormwater discharges from construction site areas are subject to the WPDES permit requirements under ch. NR 216.

(8) MORTALITY MANAGEMENT. (a) Animal carcasses may not be disposed of in a manner that results in a discharge of pollutants to surface waters, violates groundwater standards or impairs wetland functional values. Animal carcasses may not be disposed of

directly into waters of the state. In addition, carcasses may not be disposed of in liquid manure or process wastewater containment, storage or treatment facilities unless the containment, storage or treatment facility is adequately designed to contain and treat carcasses and the facility has been approved by the department for that use.

(b) The permittee shall maintain records of mortality management and disposal methods in accordance with s. NR 243.19.

Note: The permittee should be aware that there are additional restrictions on the disposal of animal carcasses in ch. 95, Stats., and ch. ATCP 3. Furthermore, there may be local regulations regarding disposal of carcasses. If a carcass is disposed of off−site, the disposal may be subject to the requirements in s. NR 502.12 or ch. NR 518.

Note: In accordance with s. 283.53, Stats., the term of a WPDES permit cannot exceed 5 years.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.14 Nutrient management. (1) NUTRIENT MANAGEMENT PLANS. (a) *General.* Permittees shall submit a nutrient management plan developed by a nutrient management planner qualified under s. ATCP 50.48 to the department for review and approval outlining the amounts, timing, locations, methods and other aspects regarding the land application of manure and process wastewater. A complete nutrient management plan shall be submitted with a permit application in accordance with s. NR 243.12. The nutrient management plan shall comply with the requirements of this section and the permittee's WPDES permit. Subject to additional requirements specified in this section and in a WPDES permit, the land application practices identified in the nutrient management plan shall, at a minimum, conform with the nutrient budgeting, soil test recommendations, application practices and restrictions contained in NRCS Standard 590.

(b) *Plan content.* The permittee's nutrient management plan shall contain information necessary to document how the operation's land application activities will comply with the restrictions in NRCS Standard 590, this chapter and the conditions of the operation's WPDES permit. In cases where there is limited acreage available for application, the department may require that the permittee submit additional or more specific information, including verification that the permittee has permission to land apply manure on fields not owned by the permittee. The department may require additional management practices be included in the nutrient management plan to ensure compliance with the requirements of this chapter and the permittee's WPDES permit.

Note: The Wisconsin Conservation Planning Technical Note WI−1 contains additional detail on the information that needs to be included in a plan drafted in accordance with NRCS Standard 590, as well as additional background information useful for nutrient management planning. While additional information beyond that outlined in the technical note is needed to comply with the requirements of this section, the technical note does provide general guidance on how to create a nutrient management plan.

(c) *Amendments.* 1. The nutrient management plan shall be reviewed and amended by the permittee on an annual basis to reflect any changes in operations. Except as provided in subd. 2., the management plan may be amended at any time provided the proposed amendments are approved in writing by the department. An amendment does not become effective until the department has reviewed and approved the amendment.

2. The department may establish a condition in the WPDES permit that allows the permittee to implement certain types of nutrient management plan amendments without obtaining, or prior to obtaining, department approval.

(2) GENERAL REQUIREMENTS. (a) A discharge of manure or process wastewater pollutants to waters of the state by a CAFO as a result of the land application of manure or process wastewater is subject to the WPDES permit terms and conditions except where the discharge is an agricultural storm water discharge. A permittee's land application practices for manure and process wastewater shall comply with this section, the terms and conditions of the WPDES permit and the permittee's approved nutrient management plan. Except as provided in s. NR 243.142 (2), the permittee is responsible for ensuring that the manure and process wastewater generated or handled at the operation is land applied or disposed of in a manner that complies with this subchapter and the terms and conditions of the WPDES permit.

(b) A permittee who land applies manure or process wastewater shall land apply all manure and process wastewater in compliance with the following requirements:

1. Manure or process wastewater may not pond on the application site.

2. During dry weather conditions, manure or process wastewater may not run off the application site, nor discharge to waters of the state through subsurface drains.

3. Manure or process wastewater may not cause the fecal contamination of water in a well.

4. Manure or process wastewater may not run off the application site nor discharge to waters of the state through subsurface drains due to precipitation or snowmelt except if the permittee has complied with all land application restrictions in this subchapter and the WPDES permit, and the runoff or discharge occurs as a result of a rain event that is equal to or greater than a 25−year, 24−hour rain event.

5. Manure or process wastewater may not be applied to saturated soils.

6. Land application practices shall maximize the use of available nutrients for crop production, prevent delivery of manure and process wastewater to waters of the state, and minimize the loss of nutrients and other contaminants to waters of the state to prevent exceedances of groundwater and surface water quality standards and to prevent impairment of wetland functional values. Practices shall retain land applied manure and process wastewater on the soil where they are applied with minimal movement.

7. Manure or process wastewater may not be applied on areas of a field with a depth to groundwater or bedrock of less than 24 inches.

8. Manure or process wastewater may not be applied within 100 feet of a direct conduit to groundwater.

9. Manure or process wastewater may not be applied within 100 feet of a private well or non−community system as defined in ch. NR 812 or within 1000 feet of a community well as defined in ch. NR 811.

10. On a field with soils that are 60 inches thick or less over fractured bedrock, manure or process wastewater may not be applied on frozen ground or where snow is present.

11. Manure or process wastewater may not be applied on fields when snow is actively melting such that water is flowing off the field.

12. Where incorporation of land applied manure is required under NRCS Standard 590, the incorporation shall occur within 48 hours of application.

13. Manure or process wastewater may not be surface applied when precipitation capable of producing runoff is forecast within 24 hours of the time of planned application.

(c) Land application of process wastewater shall be included in the permittee's nutrient management plan and shall be done in accordance with the requirements of this section, except that process wastewater may be applied to frozen or snow covered ground in accordance with the requirements in s. NR 214.17 (2) to (6) instead of subs. (6) and (7). The permittee shall specify in the nutrient management plan or permit application whether process wastewater will be applied to frozen or snow−covered ground in accordance with subs. (6) and (7) or s. NR 214.17 (2) to (6).

(d) If incorporation is required under this section or the WPDES permit, the permittee shall specify the method of incorporation in the nutrient management plan.

Note: In addition to implementing practices specified in a nutrient management plan, the permittee should consider the following factors when making decisions about the timing of application and placement of manure and process wastewater on fields: the ability of the soil to absorb or otherwise hold liquids associated with manure and process wastewater based on the soil's moisture content or permeability, if snow is present on a field or the ground is frozen, the prediction of temperature increases that will likely result in sudden snowmelts or pollutant movement, upslope

areas contributing runoff or snow melt to the site where applications occur, and other field conditions that may contribute to runoff events.

(e) A permittee shall identify as part of its nutrient management plan, to the maximum extent practicable, the presence of subsurface drainage systems in fields where its manure or process wastewater is applied.

(f) Subject to other restrictions on application rates in this section, the permittee shall use results of manure, process wastewater and soil analyses to determine nutrient application rates for manure and process wastewater.

Note: Under s. NR 243.19, the permittee shall conduct sampling of manure, process wastewater and soils, keep records associated with sampling and land application activities and submit reports to the department regarding the sample results and land application of manure and process wastewater.

Note: Pursuant to s. NR 243.142, the permittee is responsible for land application activities of the manure and process wastewater generated by the large CAFO, including the land application activities of contract haulers and employees.

(3) NUTRIENT CREDITING. A permittee's manure and process wastewater application rates shall take into account soil nutrient levels prior to landspreading, nutrient applications from other sources, including commercial fertilizers, biosolids, first and second year manure and legume credits, and other sources of nutrients that are expected to be applied or have already been applied to land where manure or process wastewater will be applied. Adjustments shall be made to assumed nutrient credits based on actual crop yields.

(4) SWQMA APPLICATION RESTRICTIONS. (a) Subject to additional restrictions in subs. (6) and (7) for the winter season, a permittee shall choose and implement one of the following options whenever manure or process wastewater is applied on areas of fields within the SWQMA:

1. Not apply manure or process wastewater within 25 feet of a navigable water, conduit to a navigable water or wetland; and inject or immediately incorporate manure and process wastewater in all other areas within the SWQMA.

2. Not apply manure or process wastewater within 25 feet of a navigable water, conduit to a navigable water or wetland; and surface apply liquid manure and process wastewater in all other areas of the SWQMA provided that all of the following conditions are met:

a. The application is on long−term no−till ground.

b. The ground has 30% crop residue or more at the time of application.

c. The hydraulic application rate is limited to that specified in Table 3.

3. Establish a 35−foot wide vegetated buffer adjacent to the navigable water, conduit to a navigable water or wetland where there is no application of manure or process wastewater on the buffer; and comply with a practice in this subd. 3. a. or b. For the purposes of this subdivision, a vegetated buffer means a narrow, permanent strip of dense perennial vegetation established parallel to the contours of and perpendicular to the dominant slope of the field for the purposes of slowing water runoff, enhancing water infiltration, and minimizing the risk of any potential nutrients or pollutants from leaving the field and reaching navigable waters.

a. Inject or immediately incorporate manure and process wastewater in all other areas within the SWQMA, or

b. Surface apply in all other areas of the SWQMA provided the ground has 30% residue or more at the time of application and the hydraulic application rate is limited in accordance with Table 3.

4. Establish a filter strip that is a minimum of 21 feet wide adjacent to the navigable water, conduit to a navigable water or wetland; and comply with a practice in this subd. 4. a. or b. The filter strip shall be designed in accordance with NRCS Standard 393, dated January 2001. NRCS Standard 393, dated January 2001, is incorporated by reference in s. NR 243.07.

Note: Copies of NRCS Standard 393, dated January 2001 and documents referenced in this standard may be inspected at the offices of the department, DATCP, NRCS, county land conservation departments and the legislative reference bureau, Madison, Wisconsin.

a. Inject or immediately incorporate manure and process wastewater in all other areas within the SWQMA, or

b. Surface apply in all other areas of the SWQMA provided the ground has 30% residue or more at the time of application and the hydraulic application rate is limited in accordance with Table 3.

5. Not apply manure or process wastewater within 100 feet of a navigable water or conduit to a navigable water.

6. Implement other practices within the SWQMA that are approved, in writing, by the department provided that the permittee demonstrates pollutant reductions are equivalent to, or better than, reductions achieved by not applying manure or process wastewater within 100 feet of downgradient navigable waters or conduits to navigable waters.

Note: The Wisconsin buffer initiative may provide additional information on the proper design and use of riparian buffers to best protect water quality.

Note: Demonstrations of equivalent practices may consist of model outputs, calculations or other means of demonstrating equivalent pollutant reductions.

(b) The nutrient management plan shall specify the land application practices that have been selected and will be followed on each field to meet the requirements of this subsection. Permittees implementing practices under par. (a) 1., 2. or 4. shall demonstrate to the department how the practices provide for pollutant reductions equivalent to, or better than, reductions achieved by not applying manure and process wastewater within 100 feet of downgradient navigable waters or conduits to navigable waters.

(c) If the application rates in Table 3 apply pursuant to any of the requirements in par. (a) 2. to 4., any additional applications made to meet the allowed nutrient crop budget shall be done with a minimum of 7 days between applications, provided the soils are not saturated.

TABLE 3
Maximum Rates of Unincorporated Liquid Manure and Process Wastewater Applied Within a SWQMA

Surface Texture Class[1]	Max Application Rate (gallons/acre)
Fine	5,000
Medium	7,500
Coarse	10,000

1 Fine – clay, silty clay, silty clay loam, clay loam.
Medium – sandy clay, sandy clay loam, loam, silt loam, silt.
Coarse – loamy sand, sandy loam, sand. This category includes peat and muck based on their infiltration capacity.

(5) PHOSPHORUS DELIVERY. (a) The permittee shall assess and minimize the potential for delivery of phosphorus to waters of the state from fields by applying its manure and process wastewater in accordance with one of the methods specified in subd. 1. or 2. The permittee shall specify the method it will apply to a field in the nutrient management plan.

1. Use the soil test phosphorus method specified in NRCS Standard 590. In addition, for applications to fields directly adjacent to, or that have been determined by the department to have a high potential to deliver phosphorus to, 303 (d) listed waters impaired by nutrients or outstanding or exceptional resource waters, the permittee may not increase soil test phosphorus levels over a crop rotation unless the permittee receives department approval, and the permittee can demonstrate that deliverability of phosphorus to these waters will not increase as a result of increases in soil test phosphorus in the field. The permittee may not raise soil test phosphorus levels over a rotation above the optimum level for the highest phosphorus demanding crop in a rotation for a field with soil test phosphorus levels below optimum levels.

Note: Maps or written descriptions of the locations of outstanding and exceptional resource and 303 (d) listed waters can be found on the department's website at http://dnr.wi.gov.

Note: In accordance with s. NR 243.14 (1) (a) and NRCS Standard 590, a permittee shall determine optimum soil phosphorus levels for various Wisconsin crops as

specified in University of Wisconsin−Extension Publication A2809, "Soil Test Recommendations for Field, Vegetable and Fruit Crops."

2. Use the phosphorus index method specified in NRCS Standard 590.

(b) If a permittee applies manure or process wastewater on fields with soil test levels greater than 100 ppm, the permittee shall comply with the requirements in both subd. 1. and 2.:

1. For fields with soil test phosphorus levels between 100 ppm and 200 ppm, the permittee shall calculate the planned average phosphorus index value for the crop rotation or for the next 4−year period, whichever time period is less. If the calculated average phosphorus index value is greater than 6, manure and process wastewater applications to that field are prohibited. If the calculated phosphorus index value is 6 or less, applications are allowed provided that the cumulative application of phosphorus from manure and process wastewater does not exceed 50% of the cumulative annual crop phosphorus removal over the rotation or the next 4−year period, whichever is less.

2. For fields with soil test phosphorus levels of 200 ppm and greater, applications of phosphorus from manure and process wastewater are prohibited unless the permittee receives department approval. The department may only approve the application if all of the following requirements are met:

a. The permittee can demonstrate that additional applications of manure or process wastewater will not significantly increase phosphorus delivery to surface waters or wetlands.

b. The permittee calculates the planned average phosphorus index value for the rotation or the next 4−year period, whichever is less and the planned average phosphorus index value is 6 or less.

c. The cumulative application of phosphorus from manure and process wastewater does not exceed 50% of the cumulative annual crop phosphorus removal over the rotation or the following 4−year period, whichever is less.

Note: Strategies for assessing and reducing phosphorus index (PI) values, algorithms, and software for calculating the Wisconsin PI can be found at http://wpindex.soils.wisc.edu/.

Note: A permittee that complies with the requirements of this section and its WPDES permit also addresses delivery of nitrogen to waters of the state.

Note: Also see s. NR 217.04 (1) (a) 5.

(6) SOLID MANURE WINTER RESTRICTIONS. The restrictions in this subsection apply to the land application of solid manure on frozen or snow covered ground.

(a) *Frozen ground−solid manure.* Unless prohibited under par. (c), solid manure may be surface applied on frozen ground if the manure is applied in compliance with the restrictions in Table 4 or otherwise immediately incorporated.

(b) *Snow covered ground−solid manure.* Unless prohibited under par. (c), solid manure may only be land applied to snow covered ground in accordance with the following:

1. If less than one inch of snow is present on the area where manure is to be land applied, the permittee may surface apply or immediately incorporate the solid manure.

Note: If there is less than one inch of snow on the ground and the ground is frozen, pursuant to par. (a), Table 4 restrictions must be followed when surface applying solid manure.

2. If one to 4 inches of snow is present on the area where manure is to be land applied, the permittee shall surface apply the manure in compliance with restrictions in Table 4 or otherwise immediately incorporate the solid manure.

3. If more than 4 inches of snow is present on the area where manure is to be land applied, the permittee shall surface apply the solid manure in compliance with the restrictions in Table 4. Incorporation of solid manure is prohibited.

Note: It is assumed that proper incorporation of solid manure is not achievable if more than 4 inches of snow is present at the time of application.

(c) *High−risk runoff period.* 1. Beginning January 1, 2008, solid manure may not be surface applied from February 1 through March 31 if any of the following conditions exist on the area of the field where the manure is to be applied:

a. Snow is present to a depth of one inch or greater.

b. The ground is frozen.

Note: Under the initial applicability provisions, the prohibition of surface application of solid manure during the high−risk period does not apply to an operation permitted as of July 1, 2007, until permit reissuance or modification. An exception to delaying compliance until permit reissuance or modification is if an operation is permitted as of July 1, 2007, and the permit requires compliance upon written department notification. Under par. (c), department notification may not require compliance prior to January 1, 2008.

Note: Solid manure may be surface applied at other times of the winter, or may be incorporated at other times during the winter, including high−risk runoff periods, if the application is done in accordance with pars. (b) and (c) and other land application requirements in this chapter.

(d) To meet the requirements of par. (c), a permittee may choose to stack solid manure generated at a production area location in accordance with s. NR 243.141 (1) rather than use a storage facility that meets the design requirements in s. NR 243.15.

TABLE 4
Restrictions for Surface Applying Solid Manure on Frozen and Snow Covered Ground

Criteria	Restrictions for fields With 0−6% slopes	Restrictions for fields with slopes > 6% and up to 9%	Restrictions for fields with slopes greater than 9%
Required fall tillage practice prior to application	Chisel or moldboard plow, no−till or a department approved equivalent[A]	Chisel or moldboard plow, no−till or department approved equivalent[A]	Not allowed
Minimum % solids allowed	12%	> 20%	Not allowed
Application rate (cumulative per acre)	Not to exceed 60 lbs. P_2O_5 per winter season, the following growing season's crop P_2O_5 budget taking into account nutrients already applied, or phosphorus application restrictions specified in a department approved nutrient management plan, whichever is less	Not to exceed 60 lbs. P_2O_5 per winter season, the following growing season's crop P_2O_5 budget taking into account nutrients already applied, or phosphorus application restrictions specified in a department approved nutrient management plan, whichever is less	Not allowed
Setbacks from surface waters	No application allowed within SWQMA	No application allowed within 2.0 x SWQMA	Not allowed
Setbacks from downslope areas of channelized flow, vegetated buffers, and wetlands	200 feet	400 feet	Not allowed
Setbacks from direct conduits to groundwater	300 feet	600 feet	Not allowed

[A] All tillage and farming practices shall be conducted in accordance with the following requirements; 0−2% slope = no contouring required, >2−6% slope = tillage and practices conducted along the general contour, >6% slope = tillage and farming practices conducted along the contour. The department may approve alternative tillage practices on a case−by−case basis in situations where conducting practices along the contour is not possible. Allowances for application on no−till fields only apply to fields where no−till practices have been in place for a minimum of 3 years.

(7) LIQUID MANURE WINTER RESTRICTIONS. The following additional restrictions in this subsection apply to the land application of liquid manure on frozen or snow covered ground:

(a) *Frozen ground−liquid manure.* Surface application of liquid manure on frozen ground is prohibited, except for an emergency situation under par. (d) or if allowed under par. (e). Injection or immediate incorporation of liquid manure is allowed on frozen ground, except if prohibited due to snow covered conditions under par. (b).

(b) *Snow covered ground−liquid manure.* Unless prohibited under par. (c) and subject to the frozen ground prohibition in par. (a), liquid manure may only be land applied to snow covered ground in accordance with the following:

1. If less than one inch of snow is present on the area where liquid manure is to be applied, surface application, injection or immediate incorporation of liquid manure is allowed.

2. If there is one to 4 inches of snow present on the area where liquid manure is to be applied, surface application of liquid manure is prohibited, except for department approved emergencies under par. (d) or if allowed under par. (e). Immediate incorporation or injection is allowed on areas where there is one to 4 inches of snow.

3. If there is greater than 4 inches of snow on the area where liquid manure is to be applied, surface application and incorporation of liquid manure is prohibited, except for department approved emergencies under par. (d) or if allowed under par. (e). Injection of liquid manure is allowed on areas where there is greater than 4 inches of snow.

(c) *High−risk runoff period.* 1. Unless there is a department approved emergency situation under par. (d), liquid manure may not be surface applied from February 1 through March 31.

Note: Prior to January 1, 2010, existing source CAFOs may surface apply liquid manure at other times of the winter. Also, during the high−risk period, liquid manure may be injected or incorporated if allowed under pars. (b) and (c) and other requirements in this chapter.

(d) *Emergency applications for liquid manure.* 1. Except as provided in subd. 3., a permittee may surface apply liquid manure on frozen or snow covered ground on an emergency basis in accordance with the restrictions in Table 5 if all of the following conditions are met:

a. The manure is from a storage or containment facility that is designed and maintained in accordance with ss. NR 243.15 and 243.17 to provide 180 days of storage for the manure.

b. The application of manure is necessitated by exceedances or expected exceedances of the margin of safety level that were unavoidable due to unusual weather conditions, equipment failure or other unforeseen circumstances beyond the control of the permittee.

c. The permittee has notified the department verbally prior to the emergency application. Unless necessitated by imminent impacts to the environment or human or animal health, the permittee may not apply manure to a field on an emergency basis until the department has verbally approved the application.

d. The permittee submits a written description of the emergency application and the events leading to the emergency application to the department within 5 days of the emergency application.

2. Allowances for emergency surface applications of liquid manure do not apply to situations where a permittee has failed to properly maintain storage capacity either through improper design or management of the storage facility, including failure to properly account for the number or volume of wastestreams entering the facility, failure to empty a storage or containment facility in accordance with permit conditions prior to the onset of frozen or snow covered ground conditions or due to an increase in animal units.

Note: The allowance for emergency surface applications in compliance with permit conditions is intended to avoid more significant impacts to human health and water quality associated with uncontrolled overflows of manure storage facilities. Causes of emergency surface applications could include conditions such as prolonged storm events or early onset of frozen ground conditions that preclude applications of manure prior to the onset of frozen or snow covered ground conditions provided that the operation made all other attempts to maintain storage volume before an emergency application became necessary.

3. The permittee shall conduct emergency surface applications of liquid manure in accordance with the restrictions in Table 5. The permittee may only conduct emergency surface applications on fields that the department has approved for emergency applications, in writing, as part of a nutrient management plan. The department may approve alternate fields and impose alternative restrictions, in writing and on a case−by−case basis, if fields that meet the restrictions in Table 5 are not available at the time of the emergency application, the permittee has explored all other options identified in its emergency response plan and the application results in a winter acute loss index value of 4 or less using the phosphorus index.

Note: The winter acute loss index value is displayed under the heading "Acute Loss Frozen Soil PI" in the cropping screen of the Snap−Plus nutrient management software program.

Note: Reporting requirements for emergency surface applications are contained in s. NR 243.19.

(e) *Existing source CAFOs−liquid manure exception.* Prior to January 1, 2010, if an existing source CAFO does not have 180 days of storage for liquid manure as specified in s. NR 243.15, the permittee may surface apply liquid manure on frozen or snow covered ground in accordance with the restrictions in Table 5 without satisfying the emergency criteria in par. (d). If a permittee does not have access to sites that meet the criteria in Table 5, the department may approve alternate sites and restrictions, in writing on a case−by−case basis as part of a nutrient management plan provided the application results in a winter acute loss index value of 4 or less using the phosphorus index. This allowance for existing source CAFOs to surface apply liquid manure on frozen or snow covered ground without satisfying the emergency criteria in par. (d) is not applicable after January 1, 2010.

Note: An existing source CAFO is defined under s. NR 243.03 (23).

(f) *Frozen liquid manure.* Liquid manure that is frozen and cannot be transferred to a manure storage facility may be surface applied on frozen or snow−covered ground in accordance with the restrictions in Table 5. Surface applications of frozen liquid manure do not require prior department approval or notification provided application sites for frozen liquid manure are identified in the approved nutrient management plan. During February and March, the permittee shall notify the department if the permittee expects to surface apply frozen liquid manure more than 5 days in any one month.

Note: Applications of frozen manure under par. (f) are limited to times when the operation's manure handling system is not functioning due to very cold weather.

TABLE 5
Frozen and Snow Covered Ground Restrictions – Emergency Surface Applications of Liquid Manure

Criteria	Restrictions for fields with 0−2% slopes	Restrictions for fields with >2−6% slopes	Restrictions for fields with slopes greater than 6%
Required fall tillage practice prior to application	Chisel or moldboard plow or department approved equivalent[A]	Chisel or moldboard plow or department approved equivalent[A]	Not allowed
Application rate (cumulative per acre)	Maximum application volume of 7,000 gallons per acre per winter season, not to exceed 60 lbs. P_2O_5, the following growing season's crop P_2O_5 budget taking into account nutrients already applied or other phosphorus application restrictions specified in a department approved nutrient management plan, whichever is less	Maximum application volume of 3,500 gallons per acre per winter season, not to exceed 30 lbs. P_2O_5, the following growing season's crop P_2O_5 budget taking into account nutrients already applied, or other phosphorus application restrictions specified in a department approved nutrient management plan, whichever is less	Not allowed
Setbacks from surface waters	No application allowed within SWQMA	No application allowed within SWQMA	Not allowed
Setbacks from downslope areas of channelized flow, vegetated buffers, wetlands	200 feet	200 feet	Not allowed
Setbacks from direct conduits to groundwater	300 feet	300 feet	Not allowed

[A] All tillage and farming practices shall be conducted along the contour in accordance with the following requirements; 0−2% slope = no contouring required, >2−6% slope = tillage and practices conducted along the general contour. The department may approve alternative tillage practices on a case−by−case basis in situations where conducting practices along the contour is not possible

(8) IDENTIFICATION OF SITES. The permittee shall submit sites that meet or are expected to meet the criteria in Tables 4 and 5 for manure and the criteria in s. NR 214.17 (2) to (6) for process wastewater to the department for review and approval as part of its nutrient management plan. In addition, the permittee shall evaluate each field at the time of application to determine if conditions are suitable for applying manure and complying with the requirements of this section. All surface applications of manure or process wastewater on frozen or snow−covered ground shall occur on those fields that represent the lowest risk of pollutant delivery to waters of the state and where the application results in a winter acute loss index value of 4 or less using the phosphorus index.

(9) ADEQUATE STORAGE. All permittees shall have and maintain adequate storage for all manure and process wastewater generated at the operation to ensure that wastes can be properly stored and land applied in compliance with the conditions and timing restrictions of the permit, nutrient management plan and this chapter. As part of the nutrient management plan, the permittee shall provide the department with documentation that it has adequate storage and methods of maintaining adequate storage for manure and process wastewater generated at the operation. For liquid manure, adequate storage means a minimum of 180 days of storage designed and maintained in accordance with ss. NR 243.15 (3) (i) to (k) and 243.17 (3) and (4).

(10) ADDITIONAL RESTRICTIONS. The department may require the permittee to implement practices in addition to or that are more stringent than the requirements specified in this section when necessary to prevent exceedances of groundwater quality standards, prevent impairments of wetland functional values, prevent runoff of manure or process wastewater during dry weather conditions or to address previous manure or process wastewater runoff events or discharges from a site to waters of the state that occurred despite compliance with this section and the conditions of a WPDES permit. These conditions may include additional restrictions on nitrogen and phosphorus loadings or other nutrients and pollutants associated with the manure or process wastewater, injection or incorporation requirements, restrictions on winter landspreading, distribution schedules, and other management or site restrictions. The department may also consider nutrient management conditions contained in ch. ATCP 50 as well as the following site−specific factors when developing permit conditions or reviewing and approving the nutrient management plan or any proposed amendments to an approved nutrient management plan:

(a) Soil limitations such as permeability, infiltration rate, drainage class and flooding hazard.

(b) Volume and water content of the waste material.

(c) Available storage capacity and method of application.

(d) Nutrient requirements of the crop or crops to be grown on the fields utilizing the manure.

(e) The presence of subsurface drainage systems.

(f) Potential impacts to waters identified as source water protection areas.

(g) Potential impact to groundwater in areas with direct conduits to groundwater, shallow soils over bedrock, highly permeable soils and shallow depth to groundwater.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.141 Manure stacking. (1) STACKING TO AVOID SURFACE APPLICATIONS IN FEBRUARY AND MARCH. For solid manure with a solids content of 16% or greater, the department may approve stacking of the manure outside of a department approved manure storage facility where a permittee chooses to stack solid manure in accordance with s. NR 243.14 (6) (d). Permittees choosing to stack solid manure under s. NR 243.14 (6) (d) shall land apply all stacked manure from a site within 8 months of the date when stacking first began at the site.

(2) OTHER STACKING ALLOWANCES. For periods when the ground is not frozen or snow−covered, the department may approve stacking of solid manure with a solids content of greater than 32% outside of a department approved manure storage facility on a case−by−case basis as allowed under a WPDES permit. Factors the department shall consider when approving stacking of solid manure on a case−by−case basis include the potential for leachate or runoff from the stack causing exceedances of surface water or groundwater quality standards or impairments to wetland functional values, information submitted or proposed to be submitted by the permittee outlining leaching and runoff characteristics of the manure, and practices to be implemented by the permittee to minimize the potential for leachate or runoff from the stack such as limiting the frequency, volume of manure to be stacked and length of stacking period.

(3) STACKING CONDITIONS. All proposed stacking sites shall be reviewed and approved by the department and identified in the permittee's nutrient management plan. Stacking approvals may be rescinded based on documented impacts to waters of the state at or from the stacking site. Stacking may only be approved provided the following requirements are met:

(a) When piled in a stack, the solid manure stack must be able to maintain its shape with minimal sloughing such that an angle of repose of 45 degrees or greater is maintained when the manure is not frozen.

(b) Stacking of solid manure outside of a department approved manure storage facility shall, at a minimum, meet the specifications in NRCS Standard 313, Table 9, dated December 2005. Alternatively, stacks may be placed on sites with soils in the hydrologic soil group D provided the manure has a solids content of greater than 32% and all other criteria in NRCS Standard 313, Table 9, dated December 2005, are met. NRCS Standard 313, dated December 2005, is incorporated by reference in s. NR 243.07.

Note: Copies of NRCS Standard 313, dated December 2005 and documents referenced in this standard may be inspected at the offices of the department, DATCP, NRCS, county land conservation departments and the legislative reference bureau, Madison, Wisconsin.

(c) The permittee shall implement any necessary additional best management practices to ensure stacking areas maintain compliance with the production area requirements in s. NR 243.13. Best management practices may include upslope clean water diversions or downslope containment structures.

Note: Manure with a solids content of approximately 20% or less may not meet the stacking criteria either because it cannot be stacked or is prone to runoff. This manure may require storage in a constructed facility during the months of February and March.

Note: Manure stacks are considered to be part of the animal production area and are subject to production area discharge restrictions in s. NR 243.13. For CAFOs, if a manure stack is not placed in a containment or storage structure or the runoff from the stack is not contained in a structure, discharges to navigable waters are not allowed under any circumstance or storm event.

(d) The stacked manure shall have minimal leaching so that leachate from the stack is contained within the designated stacking area and does not cause an exceedance of groundwater quality standards.

(e) Solid manure may not be stacked in a water quality management area.

(f) Stacks may only be placed on cropland.

(4) The department may require additional restrictions on stacking of solid manure needed to protect water quality, that include acceptable time periods for stacking, how long the manure stacks may remain in place, size of manure stacks, stack siting restrictions based on slope and soil conditions, loading and resting requirements of stacking sites, conservation practices and site monitoring requirements.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.142 Responsibility for large CAFO manure and process wastewater. (1) GENERAL. Except as provided in sub. (2), the owner or operator shall be responsible for the storage, management and land application of all manure and process wastewater generated by the operation in accordance with terms and conditions contained in the WPDES permit and the approved nutrient management plan.

Note: If manure or process wastewater is stored or sent out of the state of Wisconsin, it is not regulated under ch. NR 243 or the WPDES permit once it is out of the state.

(2) EXEMPTIONS. Upon written department approval as required under sub. (3), once the manure or process wastewater is distributed offsite, the permittee is not responsible for the land application, use or disposal of manure or process wastewater if the manure or process wastewater is distributed in compliance with the conditions of the department approval and in accordance with any of the following:

(a) *De minimus quantity of solid manure distributed.* A de minimus amount of solid manure is sold or given away to another person. Under this paragraph, a de minimus amount of solid manure means the total quantity of manure distributed to the other person is no more than 175 cubic feet within a 30−day period and no more than 525 cubic feet within a 12−month period.

(b) *Distributed as a commercial product.* 1. The manure is sold or given away to another person and that person manipulates the manure, and distributes it as a commercial fertilizer pursuant to a fertilizer license issued by DATCP or distributes it as a soil or plant additive pursuant to a soil and plant additive license issued by DATCP.

2. The permittee manipulates the manure and distributes it as a commercial fertilizer pursuant to a fertilizer license issued by DATCP or distributes it as a soil or plant additive pursuant to a soil and plant additive license issued by DATCP. The permittee is responsible for the manipulated manure until it is distributed off−site to another person.

Note: If the permittee manipulates the manure and distributes the manure under a DATCP license, the permittee responsible for the manure and the manipulated manure is subject to the WPDES permit requirements until it is distributed off−site (off of any part of the CAFO) to another person. Transfer of responsibility can only occur if the conditions in sub. (3) are met.

(c) *Alternative uses of distributed manure.* For solid manure, the manure is sold or given away to another person for landscaping, greenhouse use, use as an animal bedding product or for other beneficial purposes that do not include application to croplands.

(d) *Manure or process wastewater is distributed to another permittee.* The manure or process wastewater is sold or given away to another operation permitted under a WPDES permit that has a department approved management plan that addresses the manure or process wastewater, and the manure or process wastewater will be land applied under the other permit.

(e) *Composted manure.* The manure is sold or given away to another person who composts the manure and the department has determined that the composting process and land application or use of the distributed manure will be more appropriately regulated under ch. NR 518.

(3) DEPARTMENT APPROVAL. If a permittee wants to transfer responsibility to another person for the land application, disposal or use of manure or process wastewater that will be distributed in accordance with one of the methods in sub. (2) (b) to (e), the permittee shall obtain written department approval for the distribution. If written approval is not obtained, the permittee remains responsible for the land application, disposal and use of the distributed manure or process wastewater in accordance with the terms of the permit and this chapter. To obtain department approval for the purposes of transferring responsibility, the permittee shall comply with all of the following conditions:

(a) Neither the permittee, its agent or a contract hauler working on behalf of the permittee may land apply the distributed manure.

(b) The permittee shall demonstrate to the department that the distributed manure will be beneficially used.

(c) If the manure is distributed in accordance with sub. (2) (b) or (c), and if the person receiving the manure intends to store the manure, the permittee shall demonstrate to the department that the distributed manure will be delivered to proper storage. For purposes of this paragraph, proper storage means one of the following:

1. The distributed manure will be stored in a facility that complies with NRCS Standard 313, December 2005.

2. The distributed manure will be stored in a manner that will not cause exceedances of groundwater and surface water quality standards and will not impair wetland functional values.

Note: Proper storage may include manure stored in bags provided that the manure is dry enough to avoid leachate generation.

Note: A permittee does not need to obtain approval from the department to transfer responsibility for de minimus amounts of manure under sub. (2) (a).

(4) REVOCATION OF APPROVAL. The department may revoke its approval of the responsibility transfer if the department determines that the conditions of approval are not being met by the permittee or recipients of the manure.

(5) RECORDKEEPING AND REPORTING. (a) The permittee shall estimate the amount of manure and process wastewater distributed under sub. (2) in its nutrient management plan and record the actual amount distributed at the time of distribution. The permittee shall create and maintain records that identify the name and address of the recipient of the distributed manure or process

wastewater, the quantity distributed, and the dates of distribution. The permittee shall keep these records for at least 5 years and shall make them available to the department upon request. The permittee shall report the amount of manure distributed under sub. (2) to the department in the annual report.

(b) Prior to distribution, the permittee shall notify the recipient, in writing, of the nutrient content of the distributed manure and process wastewater based on the most recent representative sampling information that has been conducted in accordance with the permittee's WPDES permit. At a minimum, the permittee shall provide information to the recipient regarding the nitrogen and phosphorus content of the manure.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.15 Design, submittal and approval of proposed facilities or systems. (1) SUBMITTAL AND APPROVAL. (a) *Plans and specifications.* 1. Plans and specifications for proposed reviewable facilities or systems shall be submitted as part of the permit application unless written department approval is received for a later submittal. Plans and specifications shall be submitted during the term of the permit if construction of a reviewable facility or system or a modification to an existing reviewable facility or system is proposed during the term of the permit. Submittal of plans and specifications shall meet the requirements in s. NR 108.04 (2). Plans and specifications submitted for department approval shall include a narrative describing the proposed facility or system, a written management and site assessment, scaled drawings, an operation and maintenance plan and relevant calculations for the proposed facility or system. An owner or operator may not commence construction of a proposed reviewable facility or system until plans and specifications have been approved by the department in writing.

Note: Department approval should not be viewed as a guarantee that the approved facility or system or permittee can or will comply with WPDES permit conditions.

2. Barnyards, feedlots and reviewable facilities or systems may not be located within 250 feet of a private well or noncommunity system as defined in ch. NR 812 or within 1000 feet of a community well as defined in ch. NR 811.

3. Owners or operators of large CAFOs shall, at a minimum, design and construct reviewable facilities or systems that are part of the production area to meet the production area requirements in s. NR 243.13, accepted management practices, and the adequate storage requirements under ss. NR 243.14 (9) and 243.17 (3). All proposed plans and specifications, including the operation and maintenance plan, shall include a written explanation regarding the ability of the proposed facility or system to meet the production area requirement in s. NR 243.13 and the adequate storage requirements under ss. NR 243.14 (9) and 243.17 (3).

4. The department may require the submittal of additional information necessary to meet the requirements of ch. NR 150.

(b) *Department approval.* The department shall review and approve, conditionally approve or reject the plans and specifications in accordance with the timelines established in s. 281.41, Stats.

Note: In accordance with s. NR 108.04, submittals shall occur at least 90 days prior to the anticipated date upon which the owner or operator plans to commence construction.

Note: Department approval may be in addition to any local or county approvals needed. Also, a storm water construction WPDES permit may be required prior to construction pursuant to ch. NR 216.

(c) *Alternative practices or designs.* When the owner or operator of the large CAFO demonstrates that accepted management practices or those practices or design standards specified in this section are more stringent than necessary to avoid a detrimental effect on water quality, the department may approve alternative practices or design standards. This demonstration may be made during the permit issuance process under ch. 283, Stats., or during the plan review process under this section. The department may only approve alternative practices or design standards if the owner or operator can demonstrate that the design and operation of the alternative practices will achieve compliance with the requirements of ss. NR 243.13 and 243.14 (9), surface water and groundwater quality standards and the 180−day storage requirement in s. NR 243.17 (3).

(d) *Additional requirements.* As part of its written approval of plans and specifications, the department may require that accepted management practices or design standards or those practices or design standards specified in this section be superseded by more stringent operational or design requirements or practices, based on the following site−specific conditions:

1. Physical location of the facilities or systems, including depth to groundwater and bedrock and proximity to surface waters and wetlands.

2. Soil limitations such as permeability, infiltration rate, drainage class and flooding hazard.

3. Volume and water content of the waste material.

4. Available storage capacity and method of application.

5. Additional requirements or practices necessary to prevent exceedance of groundwater or surface water quality standards or impairments to wetland functional values.

(2) RUNOFF CONTROL. Runoff control systems in the production area shall be designed to comply with the applicable standards in s. NR 243.13 using permanent runoff control systems that are consistent with accepted management practices such as wastewater treatment strips, sediment basins, waste storage facilities, roof runoff management, grassed waterways and clean water diversions. Wastewater treatment strips shall be designed in accordance with NRCS Standard 635, dated January 2002. NRCS Standard 635, dated January 2002, is incorporated by reference in s. NR 243.07.

Note: Copies of NRCS Standard 635, dated January 2002 and documents referenced in this standard may be inspected at the offices of the department, DATCP, NRCS, county land conservation departments, and the legislative reference bureau, Madison, Wisconsin.

Note: In accordance with s. NR 243.13(2), operations are not allowed to discharge pollutants to navigable waters under any circumstance or storm event from parts of the production area where manure or process wastewater is not properly stored or contained by a structure. Wastewater treatment strips, grassed waterways or buffers are examples of facilities or systems that by themselves do not constitute a structure.

(3) STORAGE OR CONTAINMENT. Permittees proposing to construct storage or containment facilities shall design and install facilities that, at a minimum, meet the following requirements:

(a) *Nutrient management.* Storage and containment facilities shall be designed to provide storage capacity that is consistent with the department approved nutrient management plan and the requirement in ss. NR 243.14 (9) and 243.17 (3).

(b) *Alarm systems.* For storage or containment facilities that are either covered, buried or otherwise concealed in a manner that does not allow visual inspection of the level of manure or process wastewater in the facility, submitted designs shall include installation of a monitoring or alarm system to prevent overflows from the facility.

(c) *Leakage collection or monitoring.* 1. The permittee shall assess if a leakage collection or monitoring system or secondary containment system is necessary to prevent discharges of manure and process wastewater to groundwater or surface waters and include the assessment as part of submitted plans and specifications. If the permittee determines that these systems are necessary, it shall include plans and specifications for these systems as part of its submittal. Components of a collection or monitoring system design may include secondary containment associated with liner installation, leachate collection, leachate recirculation, monitoring sumps or monitoring wells. Components of secondary containment may include concrete or earthen berms or diversions designed to temporarily collect or divert overland flow away from surface waters or areas susceptible to groundwater contamination.

2. The department may require the installation of a leakage collection or monitoring system or secondary containment based on the following considerations:

a. Whether facilities are located on or near areas that are susceptible to groundwater contamination such as direct conduits to groundwater, sandy soils, and sites with minimal separations between bedrock and high water tables.

b. The size and depth of the facility.

c. The type of liner used.

d. Characteristics of waste being stored.

e. Other considerations based on potential impacts to waters of the state.

(d) *Process wastewater.* Storage and containment facilities for process wastewater that are stored separately from manure shall be designed and constructed in accordance with ch. NR 213 and shall be designed to achieve compliance with the applicable standards in ss. NR 243.13 and 243.14 (9).

(e) *Permanent markers.* Liquid manure and process wastewater storage and containment facilities shall be constructed with permanent markers to clearly indicate the margin of safety level and maximum operating levels. Liquid manure storage and containment facilities shall also have a marker near the bottom of the facility indicating the level at which the facility provides 180 days of storage.

(f) *Standard 313.* Manure storage and containment facilities constructed after July 1, 2007, shall, at a minimum, be designed and constructed in accordance with the design criteria contained in NRCS Standard 313, December 2005.

(g) *Solid manure−storage design capacity.* Subject to par. (h), all permittees shall have properly designed storage for all solid manure generated by the CAFO during February 1 through March 31 or shall obtain department approval to stack manure under s. NR 243.141.

(h) *Solid manure−timeframe for compliance.* 1. Except as provided in subd. 2., after July 1, 2007, all permit issuances, reissuances and modifications shall require that permittees provide solid manure storage for at least the time period from February 1 through March 31 or obtain department approval to stack manure under s. NR 243.141. If solid manure storage capacity is not obtained by an existing source CAFO at the time of public notice for a proposed permit reissuance or modification, the department shall include an evaluation and a schedule in the proposed permit to ensure that storage capacity is available by November 30th after permit reissuance or modification.

2. If an owner or operator of a large CAFO holds a WPDES permit on July 1, 2007, that requires compliance with the revised land application requirements in s. NR 243.14 upon department notification of rule changes, then the permittee shall meet the requirements in par. (g) by January 1, 2008.

(i) *Liquid manure−new source CAFOs.* All proposed liquid manure storage or containment facilities for new source CAFOs shall be designed and constructed to provide a minimum of 180 days of storage in accordance with par. (k). The design shall include a level indicator on the storage or containment facility indicating when the necessary amount of material has been removed to provide 180 days of storage. At the time of permit issuance or prior to November 30 after permit issuance, all new source CAFOs shall have properly designed liquid manure storage or containment facilities or a system of designed facilities that can contain, at a minimum, all liquid manure generated by the large CAFO for the animals present at the operation and other waste sources directed to the storage facility during any 180−day period. Properly designed storage is storage that meets the design requirements in par. (f). If a new source CAFO does not have at least 180 days of storage at the time of public notice of a proposed permit, the WPDES permit shall contain a construction schedule in order to ensure that an operation has a design volume of at least 180 days of storage prior to November 30.

(j) *Liquid manure−existing source CAFOs.* By January 1, 2010, all existing source CAFOs shall have liquid manure storage or containment facilities that are properly designed to provide a minimum of 180 days of storage in accordance with par. (k). All plans and specifications submitted on or after January 1, 2010 for proposed liquid manure storage or containment facilities by existing source CAFOs shall be designed to continue to provide a minimum of 180 days of storage in accordance with par. (k). The design shall include a marker near the bottom of the facility indicating when the necessary amount of material has been removed to provide 180 days of storage. The department may include requirements for evaluations, plan and specification submittal and construction schedules in permits prior to January 1, 2010 if necessary to insure that an operation meets the requirements for 180 days of storage for liquid manure storage or containment facilities by January 1, 2010.

(k) *Calculating design volume.* Design volume for providing 180 days of storage for liquid manure shall be calculated based on the maximum animals present at an operation for the period of time liquid manure and other wastes mixed with the liquid manure are to be stored during any 180−day period and other design considerations. Liquid manure that is not directed to any facility or structure covered by the operation's WPDES permit may be subtracted from the design volume calculations. At a minimum, design volume shall include all of the following:

1. Capacity for liquid manure that will be stored as well as process wastewater and other wastes that will be mixed and stored with the liquid manure.

2. Anticipated direct precipitation, runoff directed to the facility and evaporation for the 180−day storage period, including direct precipitation and runoff from a 100−year, 24−hour storm event for swine, veal and poultry operations that are new source CAFOs or a 25−year, 24−hour storm event for all other operations.

3. A margin of safety.

4. Other design and storage considerations specified in NRCS Standard 313, dated December 2005.

Note: 180 days of design storage is not required for process wastewater if process wastewater is stored separately from liquid manure. Requirements for storage of process wastewater are contained in s. NR 243.15 (3) (d).

(4) TRANSFER SYSTEMS. Manure and process wastewater transfer systems constructed after July 1, 2007, shall be designed, constructed and operated in accordance with the criteria contained in NRCS Standard 634, dated December 2005. NRCS Standard 634, dated December 2005 is incorporated by reference in s. NR 243.07.

Note: Copies of NRCS Standard 634, dated December 2005, and documents referenced in this standard may be inspected at the offices of the department, DATCP, NRCS, county land conservation departments, and the legislative reference bureau, Madison, Wisconsin.

(5) DIGESTERS FOR BIOGAS PRODUCTION. After July 1, 2007, digester facilities for biogas production shall be designed and constructed in accordance with NRCS Standard 313, December 2005. The department may apply additional design requirements in accordance with ch. NR 213 based on materials added or chemical characterization of the digester influent or effluent. Plans and specifications for digesters shall be submitted in accordance with sub. (1). At a minimum, the following information shall be included in the plans and specifications submitted for the construction of a digester for biogas production:

(a) The adequacy of each facility's proposed linings to prevent exfiltration of manure, untreated or digested, and other pollutants to groundwater.

(b) The proximity of bedrock and the water table to the proposed elevation of each facility's floors verified through onsite soil test borings or pits.

(c) Additional design considerations based on operation of the digester, including use of additives and operational temperatures.

(6) PERMANENT SPRAY IRRIGATION SYSTEMS. Proposed permanent spray irrigation and other treatment systems shall at a mini-

mum meet the requirements of s. NR 214.14, soil investigation and groundwater monitoring criteria in ss. NR 214.20 and 214.21, and land application requirements specified in s. NR 243.14.

Note: Permanent spray irrigation systems are considered a reviewable system or facility; therefore, plans and specifications must be submitted to the department in accordance with sub. (1).

(7) GROUNDWATER MONITORING. The department may require the installation of groundwater monitoring wells in the vicinity of manure storage facilities, runoff control systems, permanent spray irrigation systems and other treatment systems where the department determines monitoring is necessary to evaluate impacts to groundwater and geologic or construction conditions warrant monitoring. If a groundwater monitoring system is required, plans and specifications for a monitoring system shall be submitted and the system shall, at a minimum, be designed, constructed and monitored in accordance with chs. NR 140 and 141 and s. NR 214.21.

(8) COMPOSTING FACILITIES. The department shall determine if the design and operation of a manure or animal carcass composting facility that is part of the production area is more appropriately approved under this section or ch. NR 502. This determination shall be based on factors such as the type of materials mixed with the manure or animal carcass and the amount and source of the materials, the method of composting and the characteristics of the final composted material. If the department determines that design and operation requirements for a composting facility are appropriately reviewed and approved under this section, the department may still apply additional design and operation requirements contained in ch. NR 502 as needed to protect water quality and shall apply additional design and operation requirements as needed to meet the requirements in ss. NR 243.13 and 243.14 (9).

(9) FEED STORAGE. Proposed feed storage facilities and associated runoff control systems shall be designed and constructed to ensure that leachate and contaminated runoff are collected or controlled in a manner that complies with the applicable production area requirements in s. NR 243.13 and adequate storage requirements in s. NR 243.14 (9). Plans and specifications submitted to the department for proposed feed storage facilities shall include an evaluation of the need for underground leachate collection to prevent exceedances of groundwater quality standards.

(10) CONSTRUCTION AND POST CONSTRUCTION. All facilities or systems shall be constructed in accordance with the approved plans and specifications. After construction of a reviewable facility or system has been completed, the WPDES permit applicant or permittee shall submit a post−construction report to the department that includes:

(a) Scaled drawings of the constructed facility or system.

(b) Documentation that construction has complied with approved plans and specifications and applicable design standards.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.16 Evaluations of previously constructed facilities or systems. (1) All owners or operators applying for a WPDES permit shall submit an evaluation of any constructed reviewable facilities and systems not previously approved or evaluated by the department, as part of the application for a WPDES permit. Evaluations shall be submitted under the signature and the seal of a professional engineer registered in Wisconsin or other qualified individual. At a minimum, evaluations shall include the following information:

(a) A narrative providing general background and operational information on existing facilities and systems.

(b) Available post−construction documentation including the date and materials of construction.

(c) For facilities or systems that are part of the production area, an assessment of the ability of the facility or system to meet the production area requirements in s. NR 243.13, the adequate storage requirement under s. NR 243.14 (9), and accepted management practices.

(d) An assessment of the ability of the facility or system to meet the applicable design requirements identified in s. NR 243.15.

(e) Any proposed actions to address issues identified as part of the evaluation.

(2) The department may require an evaluation of a constructed facility or system previously reviewed and approved or evaluated by the department based on factors including the age of the facility or system, the facility's or system's ability to meet current design standards, requirements of this chapter or permit conditions, identified environmental impacts or physical location of the storage facility relative to waters of the state.

(3) The department may require additional practices, conditions or permittee actions based on department review of submitted evaluations of previously constructed structures or systems. This includes the installation of a leakage collection or monitoring system, secondary containment systems, or groundwater monitoring, increased inspection frequency, or replacement, upgrade or closure of systems or structures in order to ensure compliance with requirements in ss. NR 243.13 and 243.15, prevent exceedances of groundwater or surface water quality standards or to prevent impairments to wetland functional values.

(4) By January 1, 2010, permittees shall have or install the permanent markers specified in s. NR 243.15 (3) (e) to previously constructed liquid manure and process wastewater storage or containment facilities.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.17 Operation and maintenance. The permittee shall operate all constructed facilities and systems in accordance with applicable requirements of s. NR 243.13, the operation and maintenance plan for a given facility or system, and WPDES permit conditions.

(1) DIGESTER FACILITIES. (a) *Influent and effluent characterization.* 1. Prior to introducing any additives to a digester, other than manure, the permittee shall obtain written department approval. If any materials other than manure are used in the digester, the permittee shall maintain daily records of the volumes of all manure and non−manure components added to the digester influent.

2. The department may require monitoring for additional pollutants, including metals, based on the characterization of digester additives or the digester influent or effluent.

3. The department may apply additional requirements under chs. NR 213 and 214 if either:

a. Materials other than manure comprise 10% or greater of the total digester volume.

b. The department determines that the chemical characterization of the digester influent or effluent warrants additional requirements.

(2) CHEMICAL ADDITION OR DISPOSAL. (a) *Additive approval.* Except as provided in par. (b), the permittee shall notify the department and obtain written department approval prior to adding any chemicals, pollutants or other wastes to any manure, process wastewater, or stormwater storage facility or treatment system. In this section, other wastes means any waste other than manure, process wastewater or stormwater. Factors the department will consider when approving a chemical or pollutant include:

1. The beneficial use or purpose of the chemical or pollutant.

2. The potential impact the storage or land application of the mixed waste containing the chemical or pollutant may have on waters of the state.

(b) *Exceptions.* The WPDES permit may specify certain additives for which written department approval is not required before adding the substance to a treatment or storage facility.

(c) *Prohibited materials.* Medical wastes, including expired or unused antibiotics, petroleum products not designed for use in manure storage facilities, pesticides, paints, solvents and hazardous wastes may not be disposed of in storage or treatment facilities specified in par. (a).

(3) LIQUID MANURE−MAINTAINING 180 DAYS OF STORAGE. (a) Except as provided in sub. (4), once a permittee has constructed or established properly designed manure storage or containment facilities or a system of properly designed facilities that provide a minimum of 180 days of storage for liquid manure pursuant to s. NR 243.15 (3) (i) or (j), the operation shall operate and maintain the storage facilities or system such that the 180−day design requirement is met for all animals onsite, except as allowed under sub. (4).

(b) Liquid storage facilities or systems shall be emptied so that the 180−day level indicator, specified in s. NR 243.15 (3) (i) or (j), is visible on at least one day between October 1 and November 30, except for liquid manure remaining due to unusual fall weather conditions prohibiting manure applications during this time period. The permittee shall record the day on which the 180−day level indicator was visible during this time period. Permittees unable to empty their storage facility to the 180−day level indicator between October 1 and November 30, shall notify the department by December 5.

(c) Permittees shall demonstrate compliance with the 180−day design storage capacity requirement at all the following times:

1. As part of an application for permit issuance and reissuance.

2. At the time of submittal of plans and specifications for proposed reviewable facilities or systems.

3. In annual reports to the department.

4. Subject to sub. (4), when a facility is proposing, at any time, a 20% expansion in animal units or an increase by an amount of 1,000 animal units or more.

(4) LIQUID MANURE−EXCEPTIONS TO MAINTAINING 180 DAYS OF STORAGE. (a) Permittees that have maintained a minimum of 180 days of storage capacity for liquid manure in accordance with sub. (3) may be allowed to temporarily reduce this level of minimum required design capacity to 150 days design capacity if all of the following are met:

1. The reduction in storage is related to a planned increase in animal units.

2. The permittee notifies the department in writing of the proposed reduction prior to the planned expansion and reduction in 180−day design storage.

3. The permittee has a department approved expansion plan and schedule outlining how the operation will acquire or construct additional storage to achieve 180 days of storage after the expansion. The proposed schedule to acquire or construct additional storage may not exceed 24 months from the date of notification.

(b) Failure to maintain 180 days of storage under this paragraph is not reason for allowing emergency applications of liquid manure under s. NR 243.14 (7) (d).

Note: The 180−day storage capacity includes process wastewater and other wastes mixed and stored with liquid manure. See s. NR 243.15 (3) (k).

(5) SOLID MANURE−MAINTAINING STORAGE DURING FEBRUARY AND MARCH. Pursuant to s. NR 243.15 (3) (g) and (h), once a permittee has constructed or established properly designed manure storage facilities or a system of properly designed facilities that provide storage for solid manure generated at an operation site during February 1 through March 31, the operation shall operate and maintain the storage facilities or system to continue to provide storage for all solid manure generated at the operation site from February 1 to March 31, or otherwise obtain department approval to stack some or all of the manure in accordance with ss. NR 243.14 (6) (d) and 243.141 (1).

(6) DISCHARGE PREVENTION. A permittee shall operate and maintain storage and containment facilities to prevent overflows and discharges to waters of the state.

(a) The permittee may not exceed the maximum operating level in liquid storage or containment facilities except as a result of recent precipitation or conditions that do not allow removal of material from the facility in accordance with permit conditions.

(b) The permittee shall maintain a margin of safety in liquid storage or containment facilities that levels of manure, process wastewater and other wastes contained in the storage or containment facility may not exceed. Materials shall be removed from the facility in accordance with the permittee's nutrient management plan to ensure that the margin of safety is not exceeded.

(7) CLOSURE. (a) *General.* If the permittee wishes to abandon or discontinue use of structures or systems covered under this subchapter, a closure plan shall be submitted to the department for prior approval.

(b) *Manure storage facilities.* Closure of manure storage facilities shall be completed, at a minimum, according to NRCS Standard 360, dated December 2002. NRCS Standard 360, dated December 2002, is incorporated by reference in s. NR 243.07. Closure of a manure storage facility shall occur when manure has not been added or removed for a period of 24 months, unless the owner or operator can provide information to the department that the structure is designed to store manure for a longer period of time or information that the storage structure will be utilized within a specific period of time.

Note: Copies of NRCS Standard 360, dated December 2002, and documents referenced in this standard may be inspected at the offices of the department, DATCP, NRCS, county land conservation departments and the legislative reference bureau, Madison, Wisconsin.

(c) *Monitoring wells.* Groundwater monitoring wells shall be abandoned in accordance with ch. NR 141.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.18 Combined wastes. If a permittee combines manure or process wastewater with other types of waste not generated by the operation, the combined wastewater shall be stored and land applied in accordance with this subchapter. The permittee shall obtain department approval prior to combining other wastes with manure or process wastewater. The department may apply additional requirements such as the requirements in ch. NR 113, 213, 204 or 214 to the land application of the combined wastes and to the design of structures or systems associated with the combined wastes. Factors that the department shall consider in determining other applicable requirements include the volume and characteristics of the wastes or wastewater combined with the manure, requirements in other rules and any treatment of the combined wastes. The operation's nutrient management plan shall address land application of these wastes.

Note: Other wastes do not include process wastewater from the operation itself. Examples of other wastes include septage or municipal biosolids.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.19 Inspections, record keeping and reporting. (1) MONITORING AND INSPECTION PROGRAM. In accordance with a WPDES permit, the permittee shall submit a monitoring and inspection program designed to determine compliance with permit conditions that identifies the areas that the permittee will inspect in accordance with this section, the person responsible for conducting the inspections and how inspections will be recorded and submitted to the department. The monitoring and inspection program shall be consistent with the requirements in this subsection.

(a) *Inspections.* Visual inspections shall be completed by the permittee or designee in accordance with the following frequencies:

1. Daily inspection for leakage of all water lines that potentially come into contact with pollutants or drain to storage or containment structures or runoff control systems, including drinking or cooling water lines.

2. Weekly inspections to ensure proper operation of all storm water diversion devices and devices channeling contaminated runoff to storage or containment structures.

3. Weekly inspections of liquid storage and containment structures. For liquid storage and containment facilities, the berms shall be inspected for leakage, seepage, erosion, cracks and corrosion, rodent damage, excessive vegetation and other signs of structural weakness. In addition, the level of material in all liquid storage and containment facilities shall be measured and recorded in feet or inches above or below the margin of safety level.

4. Quarterly inspections of the production area, including outdoor animal pens, barnyards and raw material storage areas. CAFO outdoor vegetated areas shall be inspected quarterly.

5. Periodic inspections and calibration of landspreading equipment to detect leaks and ensure accurate application rates for manure and process wastewater. An initial calibration of spreading equipment shall be followed by additional calibration after any equipment modification that may impact application of manure or process wastewater or after changes in product or manure or process wastewater consistency. Spreading equipment for both liquid and solid manure shall be inspected just prior to the hauling season, and equipment used for spreading liquids shall be inspected at least once per month during months when hauling occurs.

6. Inspections each time manure or process wastewater is surface applied on frozen or snow−covered ground to determine if applied materials have run off the application site. Inspections shall occur during and shortly after application.

(b) *Corrective actions.* The permittee shall take corrective actions as soon as practicable to address any equipment, structure or system malfunction, failure or other problem identified through monitoring or inspections in par. (a).

(c) *Sampling.* Manure, process wastewater and soil on fields used for land application shall be sampled by the permittee in accordance with this chapter and WPDES permit conditions. Manure or process wastewater shall be analyzed on at least an annual basis for nitrogen, phosphorus and percent solids in years when the manure or process wastewater is applied. The department may require more frequent monitoring and monitoring for other parameters as part of a WPDES permit where necessary to provide representative samples of manure and process wastewater. Manure and soil samples shall be analyzed by a laboratory certified under s. ATCP 50.50. Samples of process wastewater that are not mixed with manure shall be analyzed using applicable methods specified in ch. NR 219. The department may specify alternative methods for sampling in the WPDES permit. The permittee shall submit appropriate quality control information for sampling and analysis upon written request of the department.

Note: NRCS Standard 590 requires soil testing once every 4 years.

(2) RECORD KEEPING. The permittee shall retain complete records onsite of all information required as part of this subchapter for a period of at least 5 years from the date the records are created. Results of inspection information, sampling and other information required under this section shall be recorded at the time the information is obtained.

(a) *Record keeping requirements for the production area.* The permittee shall create and retain records documenting the following information for the production area:

1. Current design of any manure storage structures, including volume for solids accumulation, design treatment volume, total design volume, and approximate number of days of storage capacity.

2. Sampling and inspection information required under sub. (1) (a) and (c).

Note: This subsection requires that specific information must be recorded when samples are taken or inspections are conducted.

3. The date that liquid storage facilities were emptied to the 180−day level indicator.

4. The date, time and estimated volume of any overflow.

5. Any actions taken to correct deficiencies as required under sub. (1) (b). Deficiencies not corrected within 30 days shall be accompanied by an explanation of the factors preventing correction.

6. Mortality management and practices used by the permittee to meet the requirements of s. NR 243.13 (8), including the dates and methods of disposal.

(b) *Record keeping requirements for land application activities.* The permittee shall create and retain the following records for activities associated with land application:

1. A copy of the nutrient management plan.

2. Daily logs recorded using form 3200−123A or a department approved equivalent, indicating the following.

a. The dates manure or process wastewater is applied to each field.

b. Fields used.

c. Acres applied.

d. Manure source and waste type.

e. Spreader volume.

f. Number of loads.

g. Whether the soil was dry, wet, saturated, frozen or snow covered at the time of application.

h. Weather conditions at time of application.

i. Whether manure was injected, incorporated or surface applied.

j. Dates of emergency applications in winter.

k. For surface applications on frozen or snow−covered ground, whether any applied manure or process wastewater ran off the application site.

3. A weather log for all dates that manure and process wastewater is spread, including weather 24 hours prior to and following application.

4. Total amount of nitrogen and phosphorus actually applied to each field, including documentation of calculations for the total amount applied.

5. Results from manure, process wastewater and soil sampling.

6. Dates of manure application equipment inspection.

7. Records of the date, recipient name and address, approximate amount and nutrient content of manure or process wastewater distributed to another person in accordance with s. NR 243.142.

(c) *Record keeping for sampling.* For each manure, process wastewater and soil sample taken, the permittee shall record the following information:

1. The date, exact place, method and time of sampling or measurements.

2. The individual or lab that performed the sampling or measurements.

3. The date the analysis was performed.

4. The individual who performed the analysis.

5. The analytical techniques or methods used.

6. The results of the analysis.

(d) *Record keeping for inspections.* For each inspection conducted by the permittee, the permittee shall record the following information:

1. The date and name of persons performing the inspection.

2. An inspection description, including components inspected.

3. Details of what was discovered during the inspection.

4. Recommendations for repair or maintenance.

5. Any corrective actions taken.

(3) REPORTING REQUIREMENTS. (a) *Corrective actions.* If the permittee fails to take corrective action within 30 days of identifying a malfunction, failure or other problem identified under sub. (1), the permittee shall contact the department immediately following the 30−day period and provide an explanation for its failure to take action.

(b) *Quarterly reporting requirements.* The permittee shall summarize the results of the inspections conducted at the production area in a written quarterly report. The reports shall be maintained onsite until submittal as part of the annual report in par. (c). The report shall include the following information:

1. Identified permit violations including all discharges of manure or process wastewater to surface waters, overflows of liquid manure or process wastewater storage and containment structures, and number of missed inspections.

2. Dates, times and approximate volume of discharges in subd. 1.

3. Corrective actions taken.

4. A summary of the condition of runoff control systems and storage and containment structures.

5. A summary of recorded levels of materials in liquid storage and containment structures, including exceedances of the maximum operating and margin of safety levels.

6. Other information requested by the department in writing or in the permit.

(c) *Annual reporting requirements.* The permittee shall submit written annual reports to the department by the date specified in the WPDES permit for all manure and other process wastewater that is generated. These annual reports shall cover the previous calendar year or cropping year, as specified in the WPDES permit, and shall include the following:

1. The quarterly reports required under par. (b).

2. The number and type of mature and immature animals at the operation and whether the animals are in open confinement or housed under roof.

3. The total amount of material in large CAFO storage or containment facilities, including manure and process wastewater generated by the large CAFO in the previous 12 months, precipitation and runoff diverted to storage or containment structures.

4. Lab analyses of manure and process wastewater land applied in the previous 12 months, and the most recent soil test analysis completed for fields receiving manure or process wastewater in the previous 12 months.

5. An annual spreading report summarizing manure and other process wastewater land application activities using form 3200−123 or a department−approved equivalent, indicating the following for each field receiving manure or process wastewater:

a. Date of application.

b. Information on the fields where manure or process wastewater is applied including field identification, slope and soil test phosphorus levels.

c. Acres applied.

d. Source and nutrient content of applied manure.

e. Current and previous field crops.

f. Nutrient balance indicating crop nutrient need in comparison to nutrients applied and credited from all sources.

g. Whether the soil was dry, wet, saturated, frozen or snow covered.

h. Method and rate of application in tons or gallons per acre.

i. Whether fields meet T.

j. Whether soil tests have been taken within the last 4 years.

k. Number of years of crop phosphorus need applied based on crop rotation.

L. For surface applications on frozen or snow−covered ground, whether any applied manure or process wastewater ran off the application site.

6. Dates on which storage facilities were emptied to the 180−day level indicator.

7. Total amount of manure and process wastewater distributed to another person by the permittee in accordance with s. NR 243.142 in the previous 12 months.

8. Total number of acres for land application covered by the nutrient management plan developed in accordance with s. NR 243.14.

9. Total number of acres actually used by the permittee for land application of manure and process wastewater in the previous 12 months.

10. A statement indicating whether the current version of the permittee's nutrient management plan was developed or approved by a certified nutrient management planner.

11. Results of land application equipment inspections and calibration.

12. Other information requested by the department in writing or in the permit.

Note: Forms 3200−123 and 3200−123A can be obtained at regional offices of the department or the department's Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, Wisconsin 53707.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

Subchapter III — Other Animal Feeding Operations

NR 243.21 Purpose. The purpose of this subchapter is to establish procedures, in cooperation with other federal and state agencies and governmental units, for addressing unacceptable practices through the issuance of a notice of discharge or WPDES permit under s. 281.16 or ch. 283, Stats. Animal feeding operations with fewer than 1000 animal units that have unacceptable practices are subject to this subchapter.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.23 General requirements for animal feeding operations. (1) LIVESTOCK PERFORMANCE STANDARDS AND PROHIBITIONS. (a) Owners and operators of animal feeding operations shall comply with the livestock performance standards and prohibitions in accordance with the requirements s. NR 151.095.

(b) The department may grant a variance to livestock performance standards or accepted management practices consistent with s. NR 151.097. A variance may not be granted to a livestock prohibition or other statutory requirements.

Note: Additional procedures for implementing cropland performance standards are included in ch. NR 151.

Note: Under s. 281.16 (3) (e), Stats., an owner or operator may not be required by the state, or a governmental unit through an ordinance or regulation, to bring existing livestock facilities into compliance with the livestock performance standards or prohibitions, technical standards or conservation practices unless cost sharing is available.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.24 Department discharge determination and NODs. Unless based on information provided as part of a WPDES permit application submitted pursuant to s. NR 243.26 (1), no determination may be made by the department that an unacceptable practice exists at an operation until there has been an onsite investigation by the department or a federal or state agency or governmental unit.

(1) CATEGORIES OF UNACCEPTABLE PRACTICES. The department shall identify the categories of discharge associated with unacceptable practices pursuant to the following criteria:

(a) *Category I.* A category I unacceptable practice is a practice or facility at an animal feeding operation that causes a point source discharge of pollutants to navigable waters by either of following means:

1. Pollutants are discharged into navigable waters through a man−made ditch, flushing system or other similar man−made device.

2. Pollutants are discharged into navigable waters that originate outside of the operation and pass over, across or through the operation or otherwise come into direct contact with the animals confined at the operation.

(b) *Category II.* A category II unacceptable practice is a practice or facility at an animal feeding operation that causes a discharge of pollutants to waters of the state that is the result of an owner's or operator's failure to comply with a livestock performance standard or prohibition in ss. NR 151.05 to 151.08. For Category II discharges, waters of the state has the meaning specified under s. 281.01 (18), Stats.

(c) *Category III.* A category III unacceptable practice is a practice or facility at an animal feeding operation that caused a discharge of pollutants to waters of the state and that is not described in par. (a) or (b).

(2) COORDINATION WITH GOVERNMENTAL UNITS. Unless an unacceptable practice is an imminent threat to public health or fish and aquatic life, the department shall notify the appropriate governmental unit prior to taking any of the following actions:

(a) Contacting an owner or operator of an animal feeding operation under the procedures in this subchapter to investigate a discharge from an unacceptable practice.

(b) Issuing an NOD for a category II unacceptable practice.

(c) Taking enforcement action under s. 281.98, Stats., against an owner or operator of an animal feeding operation for failing to comply with a livestock performance standard or prohibition.

(3) DEPARTMENT ACTION. If the department determines that an unacceptable practice exists at an operation based on its own onsite investigation, an investigation conducted by a federal or state agency or governmental unit, or information provided as part of WPDES permit application, the department may take any of the following actions:

(a) *For all unacceptable practices.* 1. The department may coordinate with a designated governmental unit to address the unacceptable practice and provide assistance to the owner or operator. This contact shall be made as soon as possible after the determination that an unacceptable practice exists at an operation to maximize opportunities for the governmental unit to provide assistance to the owner or operator.

2. The department may issue a notice of intent to issue an NOD.

(b) *Category I unacceptable practices.* For category I unacceptable practices, the department may take any of the following actions:

1. Issue an NOD to the owner or operator of the animal feeding operation to address the unacceptable practices.

2. Send the owner or operator a permit application if the owner or operator has not filed a WPDES permit application pursuant to s. NR 243.26.

3. Designate the operation as a CAFO under s. NR 243.26 (2).

4. Take direct enforcement action.

Note: In general, the department considers factors such as the degree of harm to a waterbody and the level of mismanagement or negligence by an owner or operator when deciding whether to take direct enforcement action.

(c) *Category II unacceptable practices.* For category II unacceptable practices, the department may take any of the following actions:

1. Issue an NOD if requested by a governmental unit or if a governmental unit is not addressing a facility's noncompliance with livestock performance standards or prohibitions in a manner consistent with the procedures established in ch. NR 151.

2. Follow the procedures outlined in s. NR 151.095.

3. Designate the operation as a medium or small CAFO under s. NR 243.26 (2).

(d) *Category III unacceptable practices.* For category III unacceptable practices, the department may take any of the following actions:

1. Issue an NOD to the owner or operator.

2. Take direct enforcement action.

3. Designate the operation as a medium or small CAFO under s. NR 243.26 (2).

Note: In most cases, the department will rely on governmental units to fully implement the livestock performance standards and prohibitions and address impacts to water quality from category II unacceptable practices. The department intends to issue NODs in accordance with this section in cases where a governmental unit has requested assistance in implementing and enforcing the performance standards or prohibitions or in cases where a governmental unit has failed to appropriately address unacceptable practices at animal feeding operations in a timely manner. The department recognizes that coordination between governmental units, the department of agriculture, trade and consumer protection and other state agencies is needed to achieve statewide compliance with the performance standards and prohibitions. Accordingly, the department has worked with counties, the department of agriculture, trade and consumer protection and other interested partners to develop a detailed intergovernmental strategy for achieving compliance with the performance standards and prohibitions that recognizes the procedures in this subchapter, state basin plans and the priorities established in land and water conservation plans.

(4) NOTICE OF DISCHARGE. (a) If the department issues an NOD to an owner or operator of an animal feeding operation, it shall be sent certified mail, return receipt requested or personal delivery.

(b) The department shall include all of the following information in an NOD:

1. A summary of the results of the onsite investigation used to determine that unacceptable practices exist at an operation. The summary shall include a determination of the category of the unacceptable practice that exists at the operation. The department shall provide a copy of the summary to the animal feeding operation and appropriate governmental unit.

2. One or more suggested corrective measures for the unacceptable practice identified in the summary report. The department may amend an NOD at any time to reflect changes to suggested corrective measures based on further evaluation and planning associated with addressing the unacceptable practice.

3. A list of known governmental or private services that may be available to provide technical or financial assistance.

4. For category II unacceptable practices, the NOD shall contain determinations consistent with s. NR 151.095, except that the length of the compliance period shall be determined in accordance with subd. 5. Determinations required under s. NR 151.095 may be included as part of the NOD or as amendments to the NOD.

Note: Section NR 151.095 contains the criteria and establishes the procedures for determining when cost sharing is required for eligible costs associated with corrective measures and when cost sharing is considered to have been made available. Cost sharing is not required for new facilities and for practices that do not involve eligible costs, such as moving a manure pile. Cost sharing for eligible costs may be available under ch. NR 120 or 153.

5. A reasonable compliance period for implementing necessary corrective measures shall be specified in the NOD. The compliance period identified in the NOD shall be determined by the department in accordance with the following:

a. The length of the compliance period shall be from 60 days to 2 years unless otherwise provided for in this paragraph.

b. The length of the compliance period may be less than 60 days if the site is an imminent threat to public health or fish and aquatic life.

c. The compliance period may not be more than 2 years unless an alternative compliance period has been mutually agreed upon by the department and the owner or operator of the animal feeding operation.

d. For existing practices or facilities where corrective measures require cost sharing in accordance with s. NR 151.095 and where cost sharing has not previously been made available, the compliance period specified in an NOD shall begin on the date that cost share dollars are available pursuant to s. NR 151.095 (5) (d).

Note: Cost−share dollars may be offered as part of an NOD or may be included in an amendment to an NOD.

e. For all other practices or facilities, the compliance period specified in the NOD shall begin on the date of the NOD, regardless of the availability of cost sharing.

6. An explanation of the possible consequences if the owner or operator fails to comply with the provisions of the notice, including enforcement or loss of cost sharing, or both.

(c) The department may request that proposed corrective measures be submitted to the department for review prior to implementing the corrective measures.

(d) The department may require that accepted management practices be superseded by additional design requirements or practices if they are necessary for water quality protection.

(e) The department may require that the owner or operator of the animal feeding operation, or a designee, notify the department as to the status of implementing the corrective measures prior to the end of the compliance period.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.25 NOD enforcement. (1) CATEGORIES I AND III. (a) Owners or operators or animal feeding operations that receive an NOD for a category I or III unacceptable practice shall implement corrective measures within the compliance period specified, regardless of the availability of cost sharing. The owner or operator may seek cost sharing to implement corrective measures within the specified compliance period, but if cost sharing is not available, the owner or operator shall install corrective measures to abate or eliminate the discharge without cost sharing or otherwise apply for a WPDES permit.

(b) If the owner or operator does not implement the corrective measures within the specified time frame to address category I or III unacceptable practices, the department may issue a specific WPDES permit or grant general permit coverage or the department may pursue enforcement action under ch. 283, Stats.

(2) CATEGORY II. For operations issued an NOD for a category II unacceptable practice, if the owner or operator of the animal feeding operation does not implement corrective measures within the compliance period specified in the NOD, and cost sharing has been made available for existing facilities or practices or if cost sharing is not required under s. NR 151.095, the department may take enforcement action pursuant to s. 281.98, Stats., require the submittal of a WPDES permit application or take other appropriate actions against the owner or operator.

Note: The procedures specified in this subchapter for category II unacceptable practices are limited to actions taken by the department under s. 281.98, Stats., for noncompliance with a livestock performance standard or prohibition. Pursuant to other statutory authority, the department may take direct enforcement action without cost sharing against a livestock producer for willful or intentional acts or other actions by a producer that pose an imminent or immediate threat to human health or the environment.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

NR 243.26 WPDES permits for medium and small CAFOs. (1) OPERATIONS DEFINED AS A MEDIUM CAFO. Any owner or operator of an animal feeding operation with 300 to 999 animal units shall submit a complete application for a WPDES permit to the department before a category I discharge to navigable waters occurs. An owner or operator of an animal feeding operation that has 300 to 999 animal units may not have a Category I discharge to navigable waters under s. NR 243.24 (1) (a) unless the discharge is covered by and in compliance with a WPDES permit. In the event an owner or operator of an animal feeding operation has a Category I discharge to navigable waters and that operation is not covered by a WPDES permit at the time of the discharge, the owner or operator shall immediately contact the department and shall immediately apply for a WPDES permit.

(2) OPERATIONS DESIGNATED AS MEDIUM OR SMALL CAFOS. (a) Subject to par. (c), for animal feeding operations not already defined as a CAFO under sub. (1), the department may designate an animal feeding operation with 999 animal units or less as a CAFO if all of the following occur:

1. The department conducts an onsite investigation of the operation.

2. The department determines one of the following:

a. The operation is a significant contributor of pollutants to navigable waters and the department considers the factors in par. (b) when making this determination; or

b. The operation has caused the fecal contamination of water in a well constructed in accordance with ch. NR 811 or 812.

3. For discharges of pollutants from land applied manure or process wastewater to navigable waters by an animal feeding operation with 300 to 999 animal units, the department determines the discharge was not an agricultural storm water discharge.

4. The department provides written notification to the owner or operator of the designation.

Note: Consistent with past regulatory practices, the department intends to continue to work cooperatively with animal feeding operations to address discharges to waters of the state to the maximum extent practicable in order to make designation of an operation as a CAFO unnecessary. This approach includes using voluntary programs or the issuance of an NOD, which typically provides an opportunity to obtain cost−share and technical assistance, to aid an operation to implement corrective measures.

Note: Written notification by the department may be included as part of a Category I, II or III NOD or a separate written notice may be sent to the owner or operator.

Note: For animal feeding operations with less than 300 animal units, a significant discharge of pollutants to navigable waters from land application activities is not a basis for designating an operation as a CAFO and requiring a WPDES permit−see par. (c). For animal feeding operations with 300−999 animal units, a significant discharge of pollutants to navigable waters from either the production area or land application areas is a basis for CAFO designation and WPDES permit coverage.

(b) The department shall consider all of the following factors when determining whether an operation is a significant contributor of pollutants to navigable waters under par. (a):

1. The size of the animal feeding operation and the amount of manure or process wastewater reaching navigable waters.

2. The location of the operation's production and land application areas relative to the navigable waters.

3. The means of conveyance of the manure or process wastewater into navigable waters.

4. The slope, vegetation, rainfall and other factors affecting the likelihood or frequency of discharges of manure or process wastewater into navigable waters.

5. Other factors relevant to water quality impacts.

(c) If the animal feeding operation has less than 300 animal units, the department may not designate the operation as a CAFO based on the discharge criteria in par. (a) 2. a. unless the operation had a Category I discharge to navigable waters under s. NR 243.24 (1) (a) that the department determines contributed a significant amount of pollutants to navigable waters.

(d) If an animal feeding operation is designated as a CAFO under par. (a), the owner or operator of the operation shall take one of the following actions within 90 days of written notification by the department of the designation:

1. In accordance with sub. (3), submit a completed WPDES permit application for an individual permit or for general permit coverage to the department. If a general permit is not available from the department, the permittee shall apply for an individual permit.

2. Demonstrate to the complete satisfaction of the department that the owner or operator has taken actions to permanently eliminate or significantly reduce the discharge that was the basis of the designation.

(e) If the owner or operator fails to take the actions required in par. (d) within 90 days of notification, the department may take enforcement action.

(3) APPLICATIONS. Applications shall, at a minimum, be submitted on forms 3400−25 and 3400−25A. The department may require additional information as part of the permit application consistent with the requirements of subch. II.

Note: Applications can be obtained at regional offices of the department or the department's Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, Wisconsin 53707.

(4) WPDES TERMS AND CONDITIONS. (a) WPDES permits issued under this subchapter shall contain requirements designed to implement corrective measures to address unacceptable practices, to protect groundwater and surface waters, and to prevent impairments to wetland functional values. At a minimum, permits shall contain requirements that a permittee do all of the following:

1. Comply with livestock performance standards and prohibitions, regardless of the availability of cost sharing.

2. Address manure, process wastewater and contaminated runoff from the production area in a manner that is consistent with accepted management practices and that treats or contains all manure, process wastewater and contaminated runoff for storm events up to and including a 25−year, 24−hour storm event.

Note: In determining accepted management practices for small and medium CAFOs, the department shall consider the factors contained in 40 CFR 125.3 (d).

3. Control all discharges from the production area in a manner that does not cause exceedances of groundwater or surface water quality standards or impair wetland functional values.

4. Develop and implement a nutrient management plan in accordance with s. NR 243.14 for the land application of manure and process wastewater.

5. Comply with the requirements in ss. NR 243.13 (5) (b) and (6) to (8) and 243.142 (5).

6. Conduct periodic inspections of the production area and land application equipment at a frequency specified in the WPDES permit.

7. Conduct manure, process wastewater and soil sampling in accordance with WPDES permit conditions.

8. Maintains and submit reports to the department in accordance with WPDES permit conditions.

Note: The WPDES permit requirements outlined in this subsection for small and medium CAFOs, including the requirement to develop and implement a nutrient management plan in accordance with s. NR 243.14, are only mandatory for those small and medium operations that have been issued a WPDES permit. For small and medium CAFOs that have not been issued a WPDES permit, nutrient management requirements contained in ch. ATCP 50 apply.

(b) All submitted plans and specifications or evaluations of facilities or structures required under a WPDES permit shall be done in accordance with ss. NR 243.15 and 243.16 unless the department includes alternative requirements in the WPDES permit.

Note: Under par. (b), all permitted medium and small CAFOs are required to install 180 days of storage for liquid manure.

(c) The permittee shall comply with the operation and maintenance requirements in s. NR 243.17, unless the department includes alternative requirements in the WPDES permit.

Note: Pursuant to s. 283.31, Stats., and federal regulations, a point source discharge by a medium size CAFO is prohibited unless the discharge is covered by, and in compliance with, a WPDES permit.

Note: Pursuant to ch. NR 153, operations covered by a WPDES permit are no longer eligible for cost sharing under s. 281.65, Stats.

(5) GENERAL PERMITS. The department may issue a general permit to cover a category of medium or small CAFOs.

(6) REISSUANCE OR TERMINATION OF WPDES COVERAGE. If a medium or small CAFO is covered by an individual or general WPDES permit, the owner or operator shall maintain permit coverage and shall reapply for continued coverage at least 180 days prior to the expiration of the WPDES permit unless:

(a) The permittee has ceased operation or is no longer a CAFO.

(b) The permittee has demonstrated to the satisfaction of the department that there is no remaining potential for a discharge to navigable waters of manure and process wastewater that was generated while the operation was a CAFO, or there is no remaining potential to cause well contaminations.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

Subchapter IV — CAFO Enforcement

NR 243.31 Enforcement. (1) If the department finds that the owner or operator of a CAFO violated a term or condition of its WPDES permit, the department may, following notice to the permittee, modify, suspend or revoke the permit, in whole or in part, under s. 283.53 (2), Stats.

(2) If the department finds that the owner or operator of a CAFO is violating a term or condition of its WPDES permit, any requirement in this chapter or ch. 283, Stats., or that the owner or operator of a CAFO is discharging manure or process wastewater pollutants to waters of the state without a WPDES permit, the department may refer the matter to the department of justice for enforcement, pursuant to s. 283.89, Stats. In an enforcement action, the department may seek temporary or permanent injunctive relief and may seek the civil and criminal penalties established in s. 283.91, Stats. The department may recover the costs of investigating the violation and the expenses of prosecution, including attorneys fees under s. 283.91 (5), Stats., and the costs of removing, terminating or remedying the adverse effects on the water environment under s. 283.87, Stats.

History: CR 05−075: cr. Register April 2007 No. 616, eff. 7−1−07.

Wet Detention Pond
(1001)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A permanent pool of water with designed dimensions, inlets, outlets and storage capacity, constructed to collect, detain, treat and release stormwater runoff.

II. Purposes

The primary purposes of this practice are to improve water quality and reduce peak flow.

III. Conditions Where Practice Applies

This practice applies to urban sites where stormwater runoff pollution due to particulate solids loading and attached pollutants is a concern. It also applies where increased runoff from urbanization or land use change is a concern. Site conditions must allow for runoff to be directed into the pond and a permanent pool of water to be maintained.

This standard establishes criteria for ponds to detain stormwater runoff, although some infiltration may occur. In some instances, detention ponds may present groundwater contamination risks, and this standard sets criteria for determining when liners may be necessary to address risks to groundwater. Where the detention pond will be discharging to an infiltration practice, see WDNR Conservation Practice Standards 1002-1004.

Application of this standard is not intended to address flood control. Modifications to the peak flow criteria or additional analysis of potential flooding issues may be needed or required by local authorities. For ponds used during the construction period, see WDNR Conservation Practice Standard 1064, Sediment Basin.

This practice provides a method to demonstrate that a wet detention pond achieves the total suspended solids (TSS) reduction and peak flow control required by NR 151.12, Wis. Adm. Code, for post-construction sites. Pollutant loading models such as SLAMM, P8, DETPOND or equivalent methodology may also be used to evaluate the efficiency of the design in reducing TSS.

IV. Federal, State and Local Laws

The design, construction and maintenance of wet detention ponds shall comply with all federal, state and local laws, rules or regulations. The owner/operator is responsible for securing required permits. This standard does not contain the text of any federal, state or local laws governing wet detention ponds.

The location and use of wet detention ponds may be limited by regulations relating to stormwater management, navigable waters (Ch. 30, Wis. Stats.), floodplains, wetlands, buildings, wells and other structures, or by land uses such as waste disposal sites and airports. The pond embankment may be regulated as a dam under Ch. 31, Wis. Stats., and further restricted under NR 333, Wis. Adm. Code, which includes regulations for embankment heights and storage capacities.

V. Criteria

The following minimum criteria apply to all wet detention pond designs used for the purposes stated in Section II of this standard. Use more restrictive criteria as needed to fit the conditions found in the site assessment.

A. Site Assessment – Conduct and document a site assessment to determine the site characteristics that will affect the placement, design, construction and maintenance of the pond. Document the pond design. Items to assess include:

1. At the pond site, on a site map:

    a. Identify buildings and other structures, parking lots, property lines, wells, wetlands, 100-year floodplains, surface

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

drains, navigable streams, known drain tile, roads, and utilities (both overhead and buried) showing elevation contours and other features specified by the applicable regulatory authority.

b. Show location of soil borings and test pits on site map, characterize the soils, *seasonally high groundwater level*[1], and *bedrock* conditions to a minimum depth of 5 feet below the proposed bottom of the pond or to bedrock, whichever is less. Conduct one test pit or boring per every 2 acres of permanent pool footprint, with a minimum of two per pond. Include information on the soil texture, color, structure, moisture and groundwater indicators, and bedrock type and condition, and identify all by elevation. Characterize soils using both the USDA and USCS classification systems.

Note: USCS characterization is used for soil stability assessment while USDA soil characterization identifies the soil's potential permeability rate.

c. Investigate the potential for *karst features* nearby.

2. In the watershed, on a watershed map:

a. Identify predominant soils, the drainage ways, navigable streams and floodways, wetlands, available contour maps, land cover types and known karst features. Identify the receiving surface waters, or whether the drainage basin drains directly to groundwater.

b. Show channels and overland flow before and after development, contours, and property lines.

c. Refer to the Tc (time of concentration) flow paths and subwatershed boundaries used in runoff calculations.

B. Pond Design – Properly designed wet detention ponds are effective at trapping smaller particles, and controlling peak flows (see App. C, Figures 1-3).

1. Water Quality – Pollutant reduction (TSS and phosphorus) is a function of the permanent pool area and depth, the outlet structure and the active storage volume. The following criteria apply:

a. Permanent Pool – The elevation below which runoff volume is not discharged and particles are stored.

i. Design ponds to include a permanent pool of water. The surface area of the permanent pool is measured at the invert of the lowest outlet. The minimum surface area of the permanent pool must address the total drainage area to the pond.

Note: Use App. A for the initial estimate of the permanent pool area based on drainage area. Prorate values for mixed land uses.Use Equation 1 to solve for q_o and iterate as needed.

ii. The permanent pool surface area is sized based on the particle size and the peak outflow during the 1-yr., 24-hour design storm using Equation 1:

$$\mathbf{S_a = 1.2 * (q_o / v_s)}$$ [Equation 1(a)]

or

$$\mathbf{q_o = (v_s * S_a) / 1.2}$$ [Equation 1(b)]

Where:

$\mathbf{S_a}$ = Permanent pool surface area measured at the invert of the lowest outlet of the wet detention pond (square feet)

$\mathbf{q_o}$ = Post-construction peak outflow (cubic feet/second) during the 1-yr., 24-hour design storm for the principal outlet

$\boldsymbol{v_s}$ = Particle settling velocity (feet/second)

1.2 = EPA recommended safety factor

iii. Particle settling velocities (v_s) shall be based on representative particle sizes for the desired percent TSS reduction.

- 80% (3 micron): $\boldsymbol{v_s} = 1.91 \times 10^{-5}$ ft./sec.
- 60% (6 micron): $\boldsymbol{v_s} = 7.37 \times 10^{-5}$ ft./sec.
- 40% (12 micron): $\boldsymbol{v_s} = 2.95 \times 10^{-4}$ ft./sec.

Note: Particle settling velocities were calculated assuming a specific gravity of 2.5, a water temperature of 50 degrees Fahrenheit (10 degrees C) and a kinematic viscosity of 0.01308 $cm.^2/sec.$ (Pitt, 2002). The calculations also assume discrete and quiescent settling conditions per Stoke's Law.

b. Active Storage Volume – Volume above the permanent pool that is released slowly to settle particles. Calculate the volume with the following method:

Use a hydrograph-producing method, such as the one outlined in Natural Resources Conservation Service, Technical Release 55 (TR-55), to determine the storage volume for detention ponds. This can be accomplished by using App. B where:

$\mathbf{q_o}$ = Peak outflow during the 1-yr., 24-hour design storm for the principal outlet calculated using Equation 1 (see V.B.1.a.ii).

$\mathbf{q_i}$ = Calculated post-construction peak inflow or runoff rate during the 1-yr., 24-hour design storm.

$\mathbf{V_R}$ = Calculated volume of runoff from the 1-year, 24-hour design storm for the entire contributory area.

$\mathbf{V_S}$ = The required active storage volume determined using App. B.

Note: This method may require iterative calculations.

c. Safety – Include a safety shelf (or aquatic shelf) that extends a minimum of 8 ft. from the edge of the permanent pool waterward with a slope of 10:1 (horizontal:vertical) or flatter. The maximum depth of the permanent pool of water over the shelf shall be 1.5 ft.

d. Depth – The average water depth of the permanent pool shall be a minimum of 3 ft., excluding the safety shelf area and sediment storage depth.

e. Length to Width – Maximize the length to width ratio of the flow path to prevent short-circuiting and dead zones (areas of stagnant water). See Section VII, Considerations D and N for options to prevent short circuiting.

f. Sediment Storage – After all construction has ceased and the contributory watershed has been stabilized, one of the following applies:

i. A minimum of 2 ft. shall be available for sediment storage (for a total of 5 ft. average depth, excluding the safety shelf area). For ponds greater than 20,000 sq. ft., 50% of the total surface area of the permanent pool shall be a minimum of 5 ft. deep. For ponds less than 20,000 sq. ft., maximize the area of 5 ft. depth.

ii. Modeling shows that for 20 years of sediment accumulation, less than 2 ft. sediment storage is needed (not to be less than 0.5 feet).

iii. A minimum of 4 ft. shall be available for sediment storage if the contributory area includes cropland not stabilized by any other practice, such as strip cropping, terraces and conservation tillage.

For information on sediment storage in forebays, see Section VII, Consideration C.

Note: Municipalities that use sand in the winter may consider increasing the sediment storage depth.

g. Side Slopes Below Safety Shelf – All side slopes below the safety shelf shall be 2:1 (horizontal:vertical) or flatter as required to maintain soil stability, or as required by the applicable regulatory authority.

h. Outlets – Wet detention ponds shall have both a principal outlet and an emergency spillway.

i. Prevent Damage – Incorporate into outlet design trash accumulation preventive features, and measures for preventing ice damage and scour at the outfall. Direct outlets to channels, pipes, or similar

conveyances designed to handle prolonged flows.

ii. Principal Water Quality Outlet – Design the outlet to control the proposed 2-yr., 24-hour discharge from the pond within the primary principal outlet without use of the emergency spillway or other outlet structures. If a pipe discharge is used as the primary principal outlet, then the minimum diameter shall be 4 inches. Where an orifice is used, features to prevent clogging must be added.

iii. Backward Flow – Any storm up to the 10-yr., 24-hour design storm shall not flow backward through the principal water quality outlet or principal outlet. Flap gates or other devices may be necessary to prevent backward flow.

iv. Emergency Spillway – All ponds shall have an emergency spillway. Design the spillway to safely pass peak flows produced by a 100-yr., 24-hour design storm routed through the pond without damage to the structure. The flow routing calculations start at the permanent pool elevation.

v. Peak Flow Control – Design the peak flow control to maintain stable downstream conveyance systems and comply with local ordinances or conform with regional stormwater plans where they are more restrictive than this standard. At a minimum:

a) The post-development outflow shall not exceed pre-development peak flows for the 2-yr., 24-hour design storm.

b) Use a hydrograph-producing method such as TR-55 for all runoff and flow calculations.

c) When pre-development land cover is cropland, use the runoff curve numbers in Table 1, unless local ordinances are more restrictive**.**

d) For all other pre-development land covers, use runoff curve numbers from TR-55 assuming "good hydrologic conditions."

e) For post-development calculations, use runoff curve numbers based on proposed plans.

Note: Local ordinances may require control of larger storm events than the 2-yr., 24-hour storm. In these cases, additional or compound outlets may be required.

Table 1 - Maximum Pre-Development Runoff Curve Numbers for Cropland Areas

Hydrologic Soil Group	A	B	C	D
Runoff Curve Number	55	69	78	83

2. Other Pond Criteria

a. Inflow Points – Design all inlets to prevent scour during peak flows produced by the 10-yr., 24-hr. design storm, such as using half-submerged inlets, stilling basins and rip-rap. Where infiltration may initially occur in the pond, the scour prevention device shall extend to the basin bottom.

b. Side Slopes **–** All interior side slopes above the safety shelf shall be 3:1 (horizontal:vertical), or flatter if required by the applicable regulatory authority.

c. Ponds in Series – To determine the overall TSS removal efficiency of ponds in series, the design shall use an *approved model* such as DETPOND or P8, that can track particle size distribution from one pond to the next.

d. Earthen Embankments – Earthen embankments (see App. C, Figure 3) shall be designed to address potential risk and structural integrity issues such as seepage and saturation. All constructed earthen embankments shall meet the following criteria.

i. Vegetation – Remove a minimum of 6 in. of the parent material (including all vegetation, stumps, etc.) beneath the proposed base of the embankment.

ii. Core Trench or Key-way – For embankments where the permanent pool is ponded 3 ft. or more against the embankment, include a core trench or key-way along the centerline of the embankment up to the permanent pool elevation to prevent seepage at the joint between the existing soil and the fill material. The core trench or key-way shall be a minimum of 2 ft. below the existing grade and 8 ft. wide with a side slope of 1:1 (horizontal:vertical) or flatter. Follow the construction and compaction requirements detailed in V.B.2.d.iii below for compaction and fill material.

iii. Materials – Construct all embankments with non-organic soils and compact to 90% standard proctor according to the procedures outlined in ASTM D-698 or by using compaction requirements of USDA Natural Resources Conservation Service, Wisconsin Construction Specification 3. Do not bury tree stumps, or other organic material in the embankment. Increase the constructed embankment height by a minimum of 5% to account for settling.

iv. Freeboard – Ensure that the top of embankment, after settling, is a minimum of 1 vertical foot above the flow depth for the 100-yr., 24-hr. storm.

v. Pipe Installation, Bedding and Backfill – If pipes are installed after construction of the embankment, the pipe trench shall have side slopes of 1:1 or flatter. Bed and backfill any pipes extending through the embankment with embankment or equivalent soils. Compact the bedding and backfill in lifts and to the same standard as the original embankment.

vi. Seepage – Take measures to minimize seepage along any conduit buried in the embankment. Measures such as anti-seep collars, sand diaphragms or use of bentonite are acceptable.

vii. Exterior side slopes shall be 2:1 (horizontal:vertical) or flatter, with a minimum top width of the embankment of 4 ft., or 10 ft. if access for maintenance is needed. The embankment must be designed for slope stability.

e. Topsoil and Seeding – Spread topsoil on all disturbed areas above the safety shelf, as areas are completed, to a minimum depth of 4 inches. Stabilize according to the permanent seeding criteria in WDNR Conservation Practice Standard 1059, Seeding for Construction Site Erosion Control.

f. Liners – Use the Liner Flowchart in App. D to determine when a liner is needed. For types of liners, see the Liner Flowchart and specifications in App. D. If a liner is used, provide a narrative that sets forth the liner design and construction methods.

Note: Some municipalities have wellhead protection areas and all municipalities have source water protection areas delineated by WDNR. Consult with the local community about when a liner will be needed if located within one of these areas.

g. Depth to Bedrock – The separation distance from the proposed bottom of a wet detention pond to bedrock will determine which of the following apply:

i. If the separation distance is a minimum of 5 ft. and the soil beneath the pond to bedrock is 10% fines or more, refer to the Liner Flowchart to determine if a liner may be needed for reasons other than proximity to bedrock;

ii. If the separation distance is a minimum of 3 ft. and the soil beneath the pond to bedrock is 20% fines or more, refer to the Liner Flowchart to determine if a liner may be needed for reasons other than proximity to bedrock;

iii. If conditions in (i) or (ii) are not met, then a Type B liner is required at a minimum. Refer to the Liner

Flowchart to determine if a Type A liner may be needed for reasons other than proximity to bedrock (see liner specifications in App. D);

iv. If blasting in bedrock is performed to construct a wet detention pond in bedrock, then a Type A liner is required (see liner specifications in App. D) and an engineering design must be conducted.

h. Separation from Wells – Wet detention ponds shall be constructed 400 feet from community wells (NR 811, Wis. Adm. Code) and 25 feet from non-community and private wells (NR 812, Wis. Adm. Code).

Note: The 25 foot setback from non-community and private wells is a final construction distance. This may not be sufficient to prevent running over the well with heavy equipment during construction of the pond.

i. Wetlands – For wet detention ponds that discharge to wetlands, use level spreaders or rip-rap to prevent channelization, erosion and reduce sedimentation in the wetlands.

j. Off-site runoff – Address off-site runoff in the design of a wet detention pond.

k. Aerators/Fountains – If an aerator or fountain is desired for visual and other aesthetic effects (aerators designed to mix the contents of the pond are prohibited) they must meet one of the first two items (i – ii), and items (iii) and (iv) below.

i. Increase the surface area of the wet detention pond beyond the area needed to achieve compliance with a stormwater construction site permit. The increase in surface area is equal to or greater than the *area of influence* of the aerator/fountain. Use an aerator/fountain that does not have a *depth of influence* that extends into the sediment storage depth (see App. E, Figure 4).

ii. For wet detention ponds where the surface area is no more than required to meet the stormwater construction site permit conditions, the depth of influence of the device cannot extend below the sediment storage elevation. Include in the design an automatic shut-off of the aerator/fountain as the pond starts to rise during a storm event. The aerator/fountain must remain off while the pond depth returns to the permanent pool elevation and, further, shall remain off until such time as required for the design micron particle size to settle to below the draw depth of the pump. (See V.B.1.a.iii for the design micron particle sizes that correlate with a TSS reduction.)

iii. Aerator/fountains are not allowed in wet detention ponds with less than a 5 ft. permanent pool designed depth.

iv. Configure the pump intake to draw water primarily from a horizontal plane so as to minimize the creation of a circulatory pattern from bottom to top throughout the pond.

VI. Operation and Maintenance

Develop an operation and maintenance plan that is consistent with the purposes of this practice, the wet detention pond's intended life, safety requirements and the criteria for its design. The operation and maintenance plan will:

A. Identify the responsible party for operation, maintenance and documentation of the plan.

B. Require sediment removal once the average depth of the permanent pool is 3.5 ft. At a minimum, include details in the plan on inspecting sediment depths, frequency of accumulated sediment removal, and disposal locations for accumulated sediment (NR 500, Wis. Adm. Code).

C. Include inlet and outlet maintenance, keeping embankments clear of woody vegetation, and providing access to perform the operation and maintenance activities.

D. Identify how to reach any forebay, safety shelf, inlet and outlet structures.

E. Address weed or algae growth and removal, insect and wildlife control and any landscaping practices.

F. If a liner is used, show how the liner will be protected from damage during sediment removal or when the liner is undergoing repair.

G. Prohibit excavation below the original design depth unless geotechnical analysis is completed in accordance with V.A.1.b & c.

VII. Considerations

Consider the following items for all applications of this standard:

A. Additional conservation practices should be considered if the receiving water body is sensitive to temperature fluctuations, oxygen depletion, excess toxins or nutrients.

B. To prevent nuisance from geese, consider not mowing around the pond perimeter. To maximize safety and pollutant removal, consider spreading topsoil along the safety shelf to promote plant growth.

C. For ease of maintenance, a sediment forebay should be located at each inlet (unless inlet is < 10% of total inflow or an equivalent upstream pretreatment device exists) to trap large particles such as road sand. The storage volume of the sediment forebay should be consistent with the maintenance plan, with a goal of 5%-15% of the permanent pool surface area. The sediment forebay should be a minimum depth of 3 ft. plus the depth for sediment storage.

D. The length to width ratio of the flow path should be maximized with a goal of 3:1 or greater. The flow path is considered the general direction of water flow within the pond, including the permanent pool and forebay.

E. Consider providing additional length to the safety shelf, above or below the wet pool elevation, to enhance safety.

F. To prevent damage or failure due to ice, all risers extending above the pond surface should be incorporated into the pond embankment.

G. The use of underwater outlets should be considered to minimize ice damage, accumulation of floating trash or vortex control.

H. Watershed size and land cover should be considered to ensure adequate runoff volumes to maintain a permanent pool.

I. Aesthetics of the pond should be considered in designing the shape and specifying landscape practices. Generally, square ponds are aesthetically unappealing.

J. If downstream flood management or bank erosion is a concern, consider conducting a watershed study to determine the most appropriate location and design of stormwater management structures, including consideration of potential downstream impacts on farming practices and other land uses.

K. For wet detention ponds with surface area more than 2 acres or where the fetch is greater than 500 feet, consider reinforcing banks, extending the safety shelf, vegetating the safety shelf or other measures to prevent erosion of embankment due to wave action.

L. To prevent failure, consider reinforcing earthen emergency spillways constructed over fill material to protect against erosion.

M. All flow channels draining to the pond should be stable to minimize sediment delivery to the pond.

N. Baffles may be used to artificially lengthen the flow path in the pond. In some designs, a circular flow path is set up in a pond even when the inlet and outlet are next to each other and no baffles are used. Then the flow path can be calculated using the circular path.

O. Consider using low fertilizer inputs on the embankments and collecting the clippings.

P. Consider providing a method to facilitate dewatering during accumulated sediment removal.

Q. Consider using backflow preventers to minimize fish entrapment.

R. Consider providing a terrestrial buffer of 10-15 feet around the pond if it has low or no embankments.

S. Consider a hard surface for the bottom of the forebay to ease sediment removal.

T. Use of algaecides, herbicides or polymers to control nuisance growths or to enhance sedimentation must receive a permit under NR 107, Wis. Adm. Code. Contact the appropriate DNR specialist.

U. Consider additional safety features beyond the safety shelf where conditions warrant them.

V. Consider vegetative buffer strips along drainage ways leading to the detention pond to help filter pollutants.

W. After the site assessment is complete, review and discuss it with the local administering agency at a pre-design conference to determine and agree on appropriate pond design for the site.

X. Design so that the 10-yr., 24-hour design storm does not flow through the emergency spillway. The 10-yr. design criteria protects the embankment from premature failure due to frequent or long-duration flows through the emergency spillway.

Y. Where practical, construct the emergency spillway on original grade.

Z. Conduct a groundwater boring to 15 feet below the pond and consider the historic "mottling marks" in assessing groundwater levels.

AA. For partially or fully submerged inlet pipes, consider using pipe ties or some other method to keep pipes from dislodging during frost movement.

BB. Consider employing a geotechnical engineer if stability of the embankment is a concern and to justify slopes steeper than 2.5:1.

CC. Assess potential environmental hazards at the site from previous land uses. The assessment should use historical information about the site to determine if the potential for environmental hazard exists, e.g., contaminated soils, contaminated groundwater, abandoned dumps or landfills. Contaminated areas can be located by reviewing the Bureau of Remediation and Redevelopment Tracking System (BRRTS), the DNR Registry of Waste Disposal Sites in Wisconsin and the Solid and Hazardous Waste Information System (SHWIMS) available through the WDNR website.

DD. Consider direct and indirect impacts to area wetland hydrology and wetland hydroperiod due to area hydrologic modifications that result from routing wetland source waters through a wet detention pond or releasing the discharge from a wet detention pond directly into a wetland.

EE. Consider conducting more than one test pit or boring per every 2 acres of permanent pool footprint, with a minimum of two per pond, if more are needed to determine the variability of the soil boundary or to identify perched water tables due to clay lenses. For the soils analysis, consider providing information on soil thickness, groundwater indicators—such as soil mottle or redoximorphic features—and occurrence of saturated soil, groundwater or disturbed soil.

FF. Where the soils are fine, consider groundwater monitoring if the groundwater table is less than 10 feet below the bottom of the wet pond because the water table may fluctuate seasonally. Other impacts on the groundwater table elevation may be from seasonal pumping of irrigation wells or the influence of other nearby wells. Monitoring or modeling may be necessary in these situations to identify the groundwater elevation.

GG. For additional guidance on seepage control for embankments, consult sections V.B.1.c and V.B.1.e(2) of NRCS Conservation Practice Standard 378, Pond, particularly if a wet detention pond's embankment is considered to be a dam.

VIII. 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. Plans shall specify the materials, construction processes, location, size and elevations of all components of the practice to allow for certification of construction upon completion.

IX. References

Center for Watershed Protection, *Stormwater BMP Design for Cold Climates*, December 1997.

R. Pitt and J. Voorhees, *The Design and Use of Detention Facilities for Stormwater Management Using DETPOND*, 2000.

United States Department of Agriculture, Natural Resources Conservation Service, Conservation Practice Standard 378, *Pond*, July 2001.

United States Department of Agriculture, Natural Resources Conservation Service, *Engineering Field Handbook.*

United States Department of Agriculture, Natural Resources Conservation Service, *Ponds – Planning, Design, Construction*, Agriculture Handbook 590, revised September 1997.

United States Department of Agriculture, Natural Resources Conservation Service, Technical Release 55, *Urban Hydrology for Small Watersheds*.

United States Department of Agriculture, Natural Resources Conservation Service, *Wisconsin Field Office Technical Guide, Section IV*.

United States Department of Commerce, Weather Bureau, *Rainfall Frequency Atlas of the United States, Technical Paper 40*.

University of Wisconsin – Extension, *The Wisconsin Storm Water Manual, Part Four: Wet Detention Basins*, Publication No. G3691-P.

Wisconsin State Legislature, Revisor of Statutes Bureau, *Wisconsin Administrative Code*; for information on the codes of state agencies, including WDNR, see http://www.legis.state.wi.us/rsb/code.htm.

X. Definitions

Approved Model (V.B.2.c) – A computer model that is used to predict pollutant loads from urban lands and has been approved by the applicable regulatory authorities. SLAMM and P8 are examples of models that may be used to verify that a detention pond design meets the desired total suspended solids reduction.

Area of Influence (V.B.2.k.i) – The area of influence of an aerator/fountain is a function of the circular area of impact of the return water and the mixing area of the pump, whichever is greater.

Bedrock (V.A.1.b) – Consolidated rock material and weathered in-place material with > 50%, by volume, larger than 2 mm in size.

Depth of Influence (V.B.2.k.i) – The depth of influence of an aerator/fountain is a function of the impact depth of the return water and the draw depth of the pump, whichever is greater.

Karst Feature (V.A.1.c) – An area or surficial geologic feature subject to bedrock dissolution so that it is likely to provide a conduit to groundwater. May include caves, enlarged fractures, mine features, exposed bedrock surfaces, sinkholes, springs, seeps, swallets, fracture trace (linear feature, including stream segment, vegetative trend and soil tonal alignment), Karst pond (closed depression in a karst area containing standing water) or Karst fen (marsh formed by plants overgrowing a karst lake or seepage area).

Seasonally high groundwater level (V.A.1.b) – The higher of either the elevation to which the soil is saturated as observed as a free water surface in an unlined hole, or the elevation to which the soil has been seasonally or periodically saturated as indicated by soil color patterns throughout the soil profile.

Appendix A—Calculation of Preliminary Permanent Pool Surface Area for TSS Reduction [1]

Land Use/Description/Management[2]	Total Impervious (%)[3]	80% Minimum Surface Area of the Permanent Pool (% of Watershed Area)	60% Minimum Surface Area of the Permanent Pool (% of Watershed Area)
Residential • < 2.0 units/acre (>1/2 acre lots) (low density • 2.0 - 6.0 units/acre (medium density) • > 6.0 units/acre (high density)	8 - 28 >28 -41 >41 - 68	0.7 0.8 1.0	0.3
Commercial/Office Park/Institutional/Warehouse/Industrial/Manufacturing/Storage[4] (Non-retail related business, multi-storied buildings, large heavily used outdoor parking areas, material storage, or manufacturing operations	<60 60-80 80-90 >90	1.8 2.1 2.4 2.8	0.6
Parks/Open Space/Woodland/Cemeteries	0-12	0.6	0.2
Highways/Freeways (Includes right-of-way area) • Typically grass banks/conveyance • Mixture of grass and curb/gutter • Typically curb/gutter conveyance	<60 60-90 >90	1.4 2.1 2.8	1.0

[1] Multiply the value listed by the watershed area within the category to determine the minimum pond surface area. Prorate for drainage areas with multiple categories due to different land use, management, percent impervious, soil texture, or erosion rates. For example, to achieve an 80% TSS reduction, a 50 acre (residential, 50% imperviousness) x 0.01 (1% of watershed from table) = 0.5 acre + 50 acres (office park, 85% imperviousness) x 0.024 (2.4% of watershed) = 1.2 acre. Therefore 0.5 acre + 1.2 acre = 1.7 acres for the minimum surface area of the permanent pool.

[2] For offsite areas draining to the proposed land use, refer to local municipalities for planned land use and possible institutional arrangements as a regional stormwater plan.

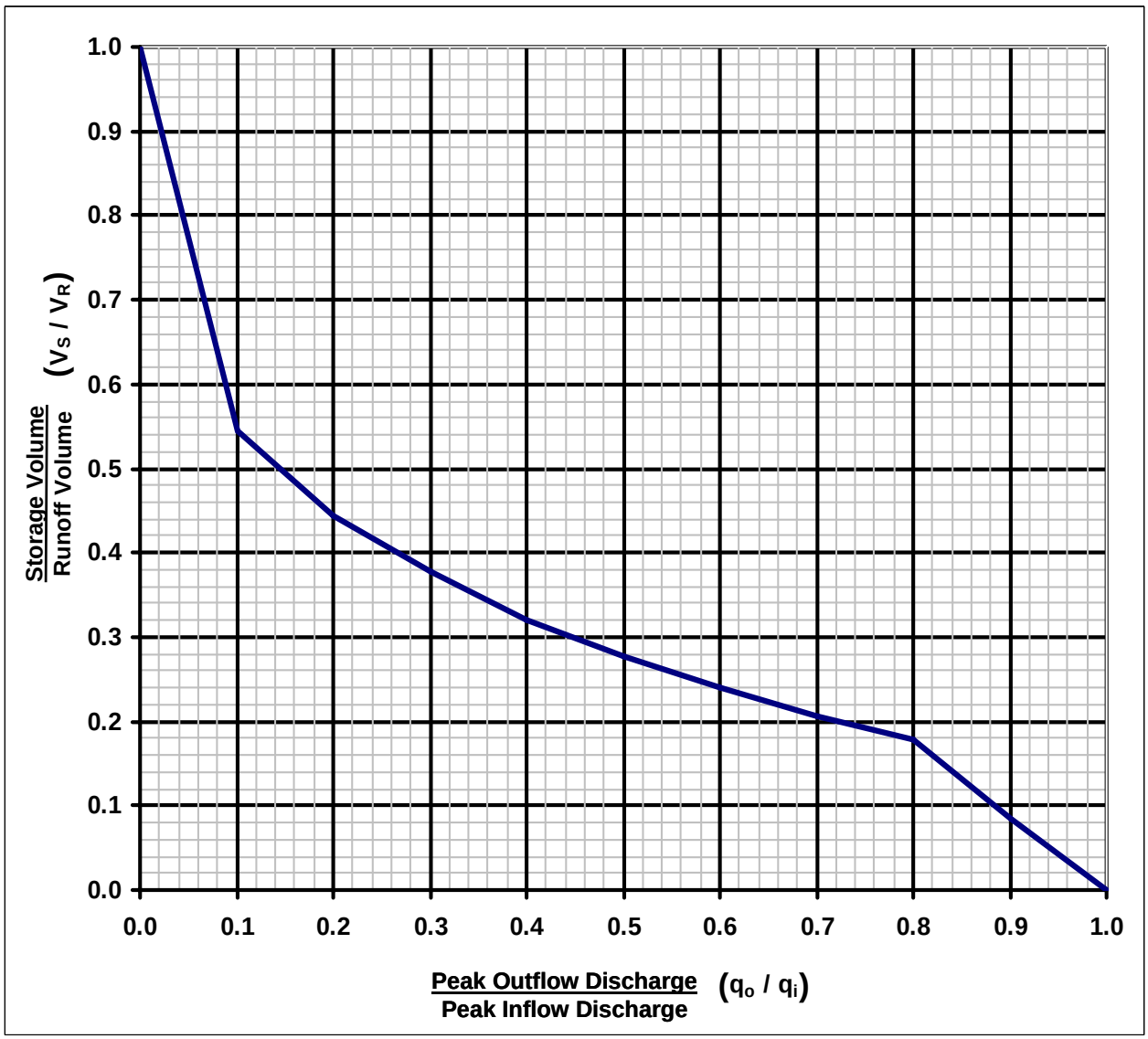
[3] Impervious surfaces include rooftops, parking lots, roads, and similar hard surfaces, including gravel driveways/parking areas.

[4] Category includes insurance offices, government buildings, company headquarters, schools, hospitals, churches, shopping centers, strip malls, power plants, steel mills, cement plants, lumber yards, auto salvage yards, grain elevators, oil tank farms, coal and salt storage areas, slaughter houses, and other outdoor storage or parking areas.

Source: This table was modified from information in "The Design and Use of Detention Facilities for Stormwater Management Using DETPOND" by R. Pitt and J. Voorhees (2000).

Appendix B

Approximate Detention Basin Routing for Type II Storms



Source: Technical Release 55, United States Department of Agriculture, Natural Resources Conservation Service, Washington, D.C. 1986. NRCS Bulletin No. WI-210-8-16 (Sept. 12, 1988) amended the TR-55 routing graph for Type II storms to include flows outside the original range.

Appendix B (cont'd.)

Rainfall Quantities:

Table 2 provides a summary of the 1-year, 24-hour rainfall totals using NRCS mandated TP-40, which has not been updated since 1961. Table 3 provides a summary of more current data from the Rainfall Frequency Atlas of the Midwest published in 1992. Local requirements may dictate the use of one dataset over the other.

Table 2 – Rainfall for Wisconsin Counties for a 1-year, 24-hour Rainfall[1]	
Inches of Rainfall	County
2.1 in.	Door, Florence, Forest, Kewaunee, Marinette, Oconto, Vilas
2.2 in.	Ashland, Bayfield, Brown, Calumet, Douglas, Iron, Langlade, Lincoln, Manitowoc, Menominee, Oneida, Outagamie, Price, Shawano, Sheboygan
2.3 in.	Barron, Burnett, Dodge, Fond du Lac, Green Lake, Marathon, Milwaukee, Ozaukee, Portage, Racine, Rusk, Sawyer, Taylor, Washburn, Washington, Waukesha, Waupaca, Waushara, Winnebago, Wood
2.4 in.	Adams, Chippewa, Clark, Columbia, Dane, Dunn, Eau Claire, Jackson, Jefferson, Juneau, Kenosha, Marquette, Pepin, Pierce, Polk, Rock, St. Croix, Walworth
2.5 in.	Buffalo, Green, Iowa, La Crosse, Monroe, Richland, Sauk, Trempealeau, Vernon
2.6 in.	Crawford, Grant, Lafayette
[1]TP – 40: Rainfall Frequency Atlas of the United States, U.S. Department of Commerce Weather Bureau.	

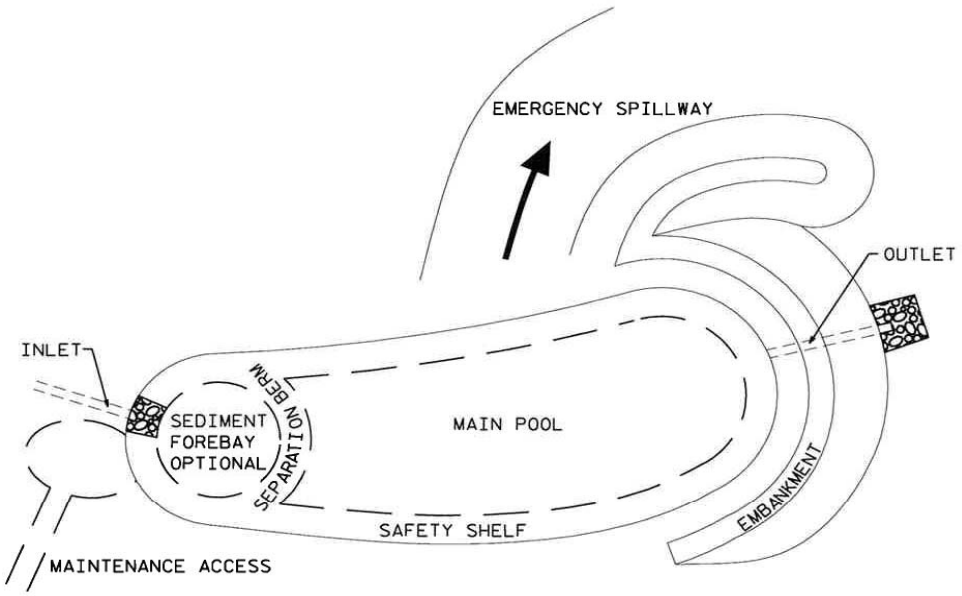
Table 3 - Rainfall for Wisconsin Counties for a 1-year, 24-hour Rainfall[2]		
Zone	Inches of Rainfall	County
1	2.22	Douglas, Bayfield, Burnett, Washburn, Sawyer, Polk, Barron, Rusk, Chippewa, Eau Claire
2	2.21	Ashland, Iron, Vilas, Price, Oneida, Taylor, Lincoln, Clark, Marathon
3	1.90	Florence, Forest, Marinette, Langlade, Menominee, Oconto, Door, Shawano
4	2.23	St. Croix, Dunn, Pierce, Pepin, Buffalo, Trempealeau, Jackson, La Crosse, Monroe
5	2.15	Wood, Portage, Waupaca, Juneau, Adams, Waushara, Marquette, Green Lake
6	1.96	Outagamie, Brown, Kewaunee, Winnebago, Calumet, Manitowoc, Fond du Lac, Sheboygan
7	2.25	Vernon, Crawford, Richland, Sauk, Grant, Iowa, Lafayette
8	2.25	Columbia, Dodge, Dane, Jefferson, Green, Rock
9	2.18	Ozaukee, Washington, Waukesha, Milwaukee, Walworth, Racine, Kenosha
[2]Bulletin 71: Rainfall Frequency Atlas of the Midwest, Midwest Climate Center and Illinois State Water Survey, 1992.		

Appendix B (cont'd.)

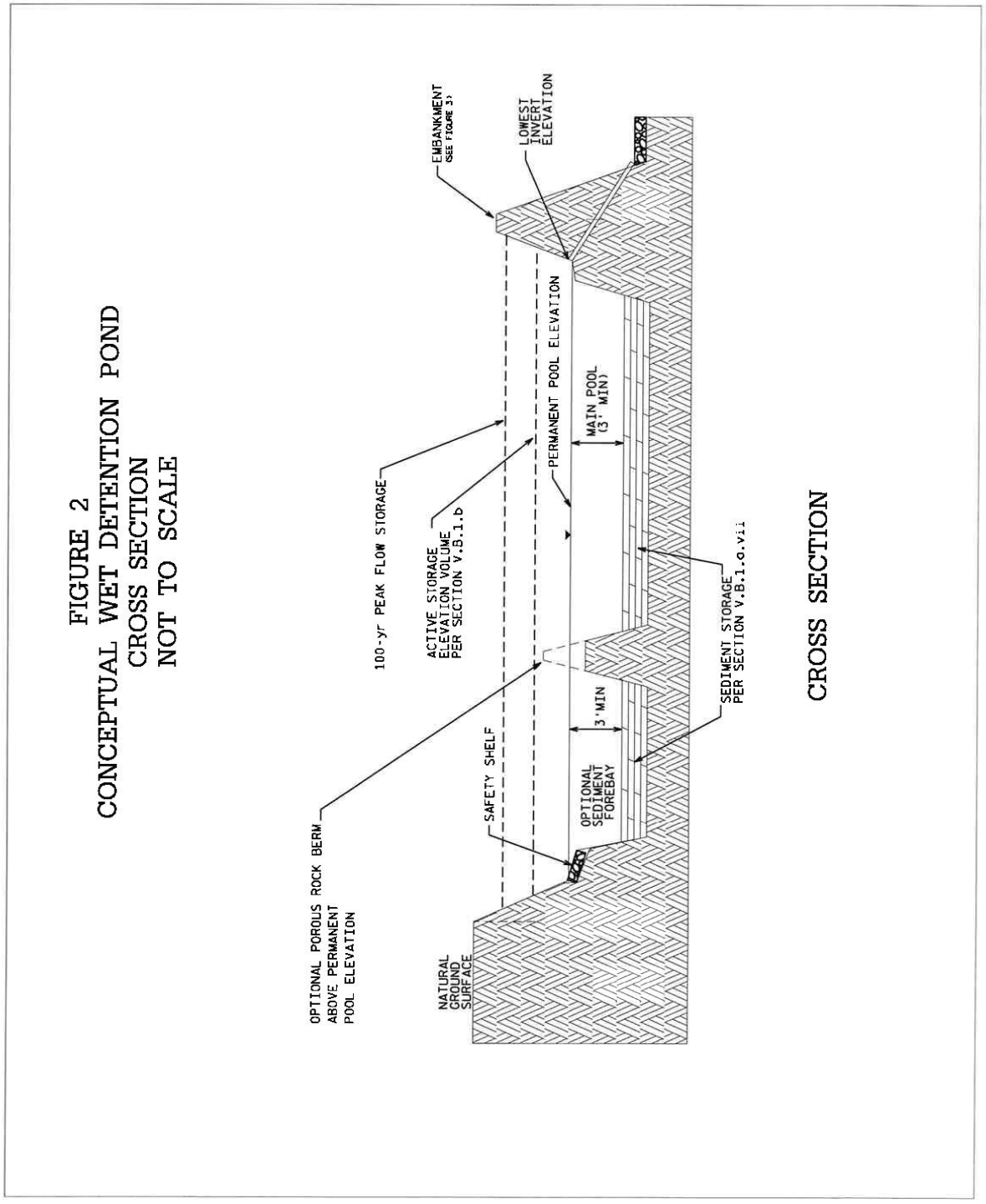
Table 4 – Runoff for Selected Curve Numbers and Rainfall Amounts[1]											
Runoff Depth in Inches for Curve Number of:											
Rainfall (inches)	50	55	60	65	70	75	80	85	90	95	98
1.9	0.00	0.01	0.04	0.11	0.20	0.33	0.50	0.72	1.01	1.39	1.68
1.96	0.00	0.01	0.05	0.12	0.23	0.36	0.54	0.77	1.06	1.44	1.73
2.1	0.00	0.02	0.08	0.16	0.28	0.43	0.62	0.87	1.18	1.58	1.87
2.15	0.00	0.03	0.09	0.18	0.30	0.46	0.66	0.91	1.22	1.63	1.92
2.18	0.00	0.03	0.10	0.19	0.31	0.47	0.68	0.93	1.25	1.65	1.95
2.2	0.00	0.04	0.10	0.19	0.32	0.48	0.69	0.94	1.27	1.67	1.97
2.21	0.00	0.04	0.10	0.20	0.32	0.49	0.69	0.95	1.28	1.68	1.98
2.22	0.00	0.04	0.10	0.20	0.33	0.49	0.70	0.96	1.28	1.69	1.99
2.23	0.01	0.04	0.11	0.20	0.33	0.50	0.71	0.97	1.29	1.70	2.00
2.25	0.01	0.04	0.11	0.21	0.34	0.51	0.72	0.98	1.31	1.72	2.02
2.3	0.01	0.05	0.12	0.23	0.36	0.54	0.75	1.02	1.35	1.77	2.07
2.4	0.02	0.07	0.15	0.26	0.41	0.59	0.82	1.10	1.44	1.87	2.17
2.5	0.02	0.08	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
2.6	0.03	0.10	0.20	0.34	0.50	0.71	0.96	1.26	1.62	2.06	2.37
[1]NRCS TR-55, Equations 2-1 to 2-4 used to determine runoff depths.											

Appendix C—Pond Geometry

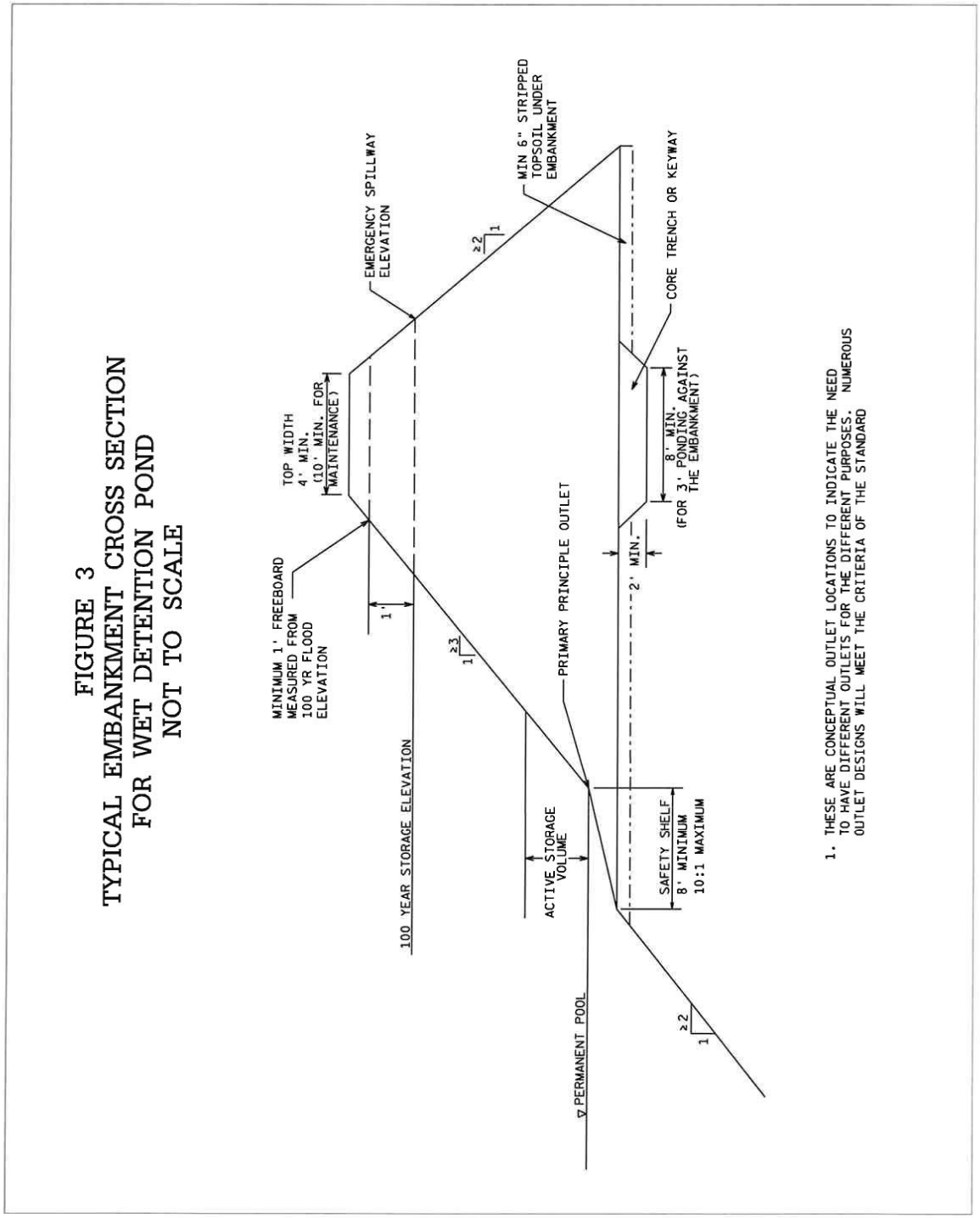
FIGURE 1
CONCEPTUAL WET DETENTION POND
PLAN VIEW
NOT TO SCALE



Appendix C—Pond Geometry (cont'd.)



Appendix C—Pond Geometry (cont'd.)



Appendix D—Pond Liner Design, Decision Flowchart

Pond Liner Design Specifications for Three Levels of Liners

A. Type A Liners—for sites with the highest potential for groundwater pollution. They include:
- Clay (natural soil, not bentonite)
- High Density Polyethylene (HDPE)
- Geosynthetic Clay Liners (GCL)

1. Clay liner criteria (essentially the same as the clay below landfills but not as thick):
   a. 50% fines (200 sieve) or more.
   b. An in-place hydraulic conductivity of 1×10^{-7} cm./sec. or less.
   c. Average liquid limit of 25 or greater, with no value less than 20.
   d. Average PI of 12 or more, with no values less than 10.
   e, Clay installed wet of optimum if using standard Proctor, and 2% wet of optimum if using modified Proctor.
   f. Clay compaction and documentation as specified in NRCS Wisconsin Construction Specification 300, Clay Liners.
   g. Minimum thickness of two feet.
   h. Specify method for keeping the pool full or use of composite soils below liner.
2. HDPE liner criteria:
   a. Minimum thickness shall be 60 mils.
   b. Design according to the criteria in Table 3 of the NRCS 313, Waste Storage Facility technical standard.
   c. Install according to NRCS Wisconsin Construction Specification 202, Polyethylene Geomembrane Lining.
3. GCL liner criteria:
   a. Design according to the criteria in Table 4 of NRCS 313, Waste Storage Facility technical standard.
   b. Install according to NRCS Wisconsin Construction Specification 203, Geosynthetic Clay Liner.

B. Type B Liners—for sites with medium potential for groundwater pollution or where need for a full pool level is high. They include:
- All liners meeting Type A criteria
- Clay
- HDPE
- Polyethylene Pond Liner (PPL)

1. Clay liner criteria:
   a. 50% fines (200 sieve) or more.
   b. An in-place hydraulic conductivity of 1×10^{-6} cm./sec. or less.
   c. Average liquid limit value of 16 or greater, with no value less than 14.
   d. Average PI of 7 or more with no values less than 5.
   e. Clay compaction and documentation as specified in NRCS Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.
   f. Minimum thickness of two feet.
   g. Specify method for keeping the pool full or use of composite soils below liner.
2. HDPE liner criteria:
   a. Minimum thickness shall be 40 mils.
   b. All other criteria same as for Type A HDPE liner.
3. PPL liner criteria:
   a. Minimum thickness shall be 30 mils.
   b. All other criteria same as for Type A HDPE liner.

C. Type C Liners—for sites with little potential for groundwater pollution or where the need for a full pool is less important. They include:
- All liners meeting Type A or B criteria
- Silts and clays
- HDPE (<40 mil)
- PPL (20-24 mil)
- PVC (30-40 mil)
- EPDM (45 mil)

1. Silt/Clay liner criteria:
   a. 50% fines (200 sieve), or 20% fines and a PI of 7.
   b. Soil compaction and documentation as specified in NRCS Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.
   c. Minimum thickness of two feet.
   d. Specify method for keeping the pool full or use of composite soils below liner.

D. Liner Elevation—All liners must extend above the permanent pool up to the elevation reached by the 2-yr., 24-hour storm event.

E. For synthetic liners, follow the manufacturers' recommendations for installation.

Appendix E—Aerators/Fountains

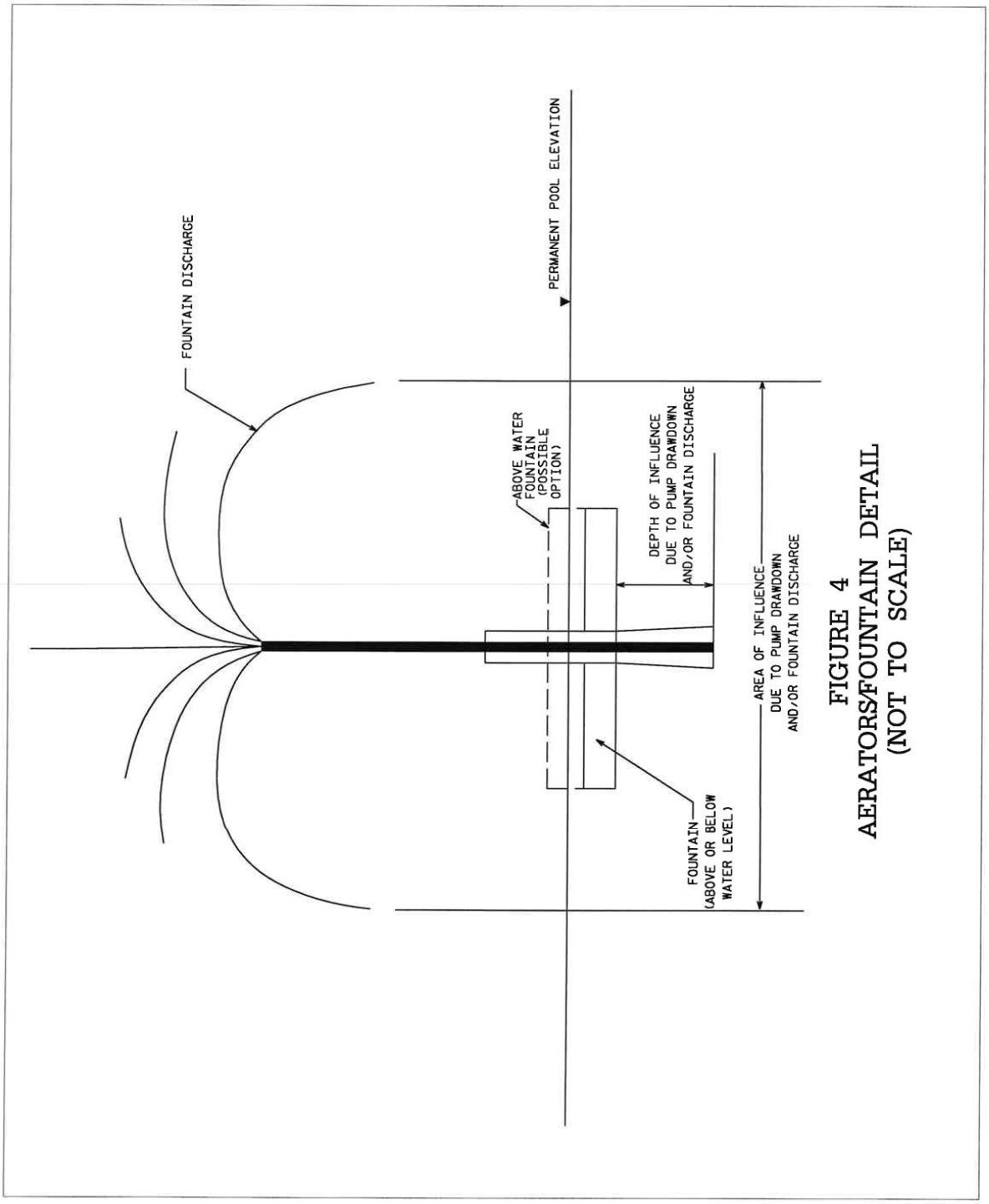


FIGURE 4
AERATORS/FOUNTAIN DETAIL
(NOT TO SCALE)

Non-Channel Erosion Mat

(1052)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A protective soil cover made of straw, wood, coconut fiber or other suitable plant residue, or plastic fibers formed into a mat, usually with a plastic or biodegradable mesh on one or both sides. Erosion mats are rolled products available in many varieties and combinations of material and with varying life spans.

II. Purpose

The purpose of this practice is to protect the soil surface from the erosive effect of rainfall and prevent *sheet erosion* [1] during the establishment of grass or other vegetation, and to reduce soil moisture loss due to evaporation. This practice applies to both *Erosion Control Revegetative Mats (ECRM*) and *Turf-Reinforcement Mats* (*TRM*).

III. Conditions Where Practice Applies

This standard applies to erosion mat selection for use on erodible slopes.

This standard is not for channel erosion; for channel applications reference WDNR Conservation Practice Standard (1053) Channel Erosion Mat.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of erosion mat. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum allowable standards for design, installation and performance requirements. Only Wisconsin Department of Transportation (WisDOT) Erosion Control Product Acceptability List (PAL) approved mats will be accepted for use in this standard.

Slope and slope length shall be taken into consideration. This information can be found in the Slope Erosion Control Matrix located in the PAL.

To differentiate applications Erosion mats are organized into three Classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic mat with photodegradable plastic or biodegradable netting.

   1. **Type A** – Use on erodible slopes 2.5:1 or flatter.

   2. **Type B** – Double netted product for use on erodible slopes 2:1 or flatter.

B. **Class I, Urban**: A short-term duration (minimum of 6 months), light duty, organic erosion control mat for areas where mowing may be accomplished within two weeks after installation.

   1. **Urban, Type A** – Use on erodible soils with slopes 4:1 or flatter.

   2. **Urban, Type B** – A double netted product for use on slopes 2.5:1 or flatter.

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

C. **Class II**: A long-term duration (three years or greater), organic erosion control revegetative mat.

1. **Type A** – Jute fiber only for use on slopes 2:1 or flatter for sod reinforcement.

2. **Type B –** For use on slopes 2:1 or greater made with plastic or biodegradable net.

3. **Type C** – A woven mat of 100% organic fibers for use on slopes 2:1 or flatter and in environmentally and biologically sensitive areas where plastic netting is inappropriate.

D. **Class III**: A permanent 100% synthetic ECRM or TRM. Either a soil stabilizer Type A or Class I, Type A or B erosion mat must be placed over the soil filled TRM.

1. **Type A** – An ECRM for use on slopes 2:1 or flatter.

2. **Type B or C** – A TRM for use on slopes 2:1 or flatter.

3. **Type D** – A TRM for use on slopes 1:1 or flatter.

E. **Material Selection**

1. For mats that utilize netting, the netting shall be bonded to the parent material to prevent separation of the net for the life of the product.

2. For urban class mats the following material requirements shall be adhered to:

a. Only 100% organic biodegradable netted products are allowed, including parent material, stitching, and netting.

b. The netting shall be stitched with biodegradable thread/yarn to prevent separation of the net from parent material.

c. All materials and additive components used to manufacture the anchoring devices shall be completely biodegradable as determined by ASTM D 5338.

d. Mats with photodegradable netting shall not be installed after September 1st.

F. **Installation**

1. ECRMs shall be installed after all topsoiling, fertilizing, liming and seeding is complete.

2. The mat shall be in firm and intimate contact with the soil. It shall be installed and anchored per the manufacturer's recommendation.

3. TRM shall be installed in conjunction with the topsoiling operation and shall be followed by ECRM installation.

4. At time of installation, document the manufacturer and mat type by retention of material labels and manufacturer's installation instructions. Retain this documentation until the site has been stabilized.

VI. Considerations

A. Urban mats may be used in lieu of sod.

B. Documentation of materials used, monitoring logs, project diary and weekly inspection forms, including erosion and stormwater management plans, should be turned over to the authority charged with long term maintenance of the site.

VII. Plans and Specifications

A. Plans and specifications for installing erosion mat shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall address the following:

1. Location of erosion mat

2. Installation Sequence

3. Material specification conforming to standard

B. All plans, standard detail drawings, or specifications shall include schedule for installation, inspection, and maintenance. The responsible party shall be identified.

VIII. Operation and Maintenance

A. Erosion mat shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.

B. If there are signs of rilling under the mat, install more staples or more frequent anchoring trenches. If rilling becomes severe enough to prevent establishment of vegetation, remove the section of mat where the damage has occurred. Fill the eroded area with topsoil, compact, reseed and replace the section of mat, trenching and overlapping ends per manufacturer's recommendations. Additional staking is recommended near where rilling was filled.

C. If the reinforcing plastic netting has separated from the mat, remove the plastic and if necessary replace the mat.

D. Maintenance shall be completed as soon as possible with consideration to site conditions.

IX. References

WisDOT "Erosion Control Product Acceptability List" is available online at http://www.dot.wisconsin.gov/business/engrserv/pal.htm Printed copies are no longer distributed.

Field Code Changed

X. Definitions

Sheet and Rill Erosion (II): Sheet and rill erosion is the removal of soil by the action of rainfall and shallow overland runoff. It is the first stage in water erosion. As flow becomes more concentrated rills occur. As soil detachment continues or flow increases, rills will become wider and deeper forming gullies.

Erosion Control Revegetative Mats (ECRM) (II): erosion control revegetative mats designed to be placed on the soil surface.

Turf-Reinforcement Mats (TRM) (II): turf-reinforcement mats are permanent devices constructed from various types of synthetic materials and buried below the surface to help stabilize the soil. TRMs must be used in conjunction with an ECRM or an approved Type A soil stabilizer.

Channel Erosion Mat

(1053)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A protective soil cover of straw, wood, coconut fiber or other suitable plant residue, or plastic fibers formed into a mat, usually with a plastic or biodegradable mesh on one or both sides. Erosion mats are rolled products available in many varieties and combination of materials and with varying life spans.

II. Purpose

The purpose of this practice is to protect the channel from erosion or act as turf reinforcement during and after the establishment of grass or other vegetation in a channel. This practice applies to both *Erosion Control Revegative Mats* (*ECRM*[1]) and *Turf-Reinforcement Mats* (*TRM*).

III. Conditions Where Practice Applies

This standard applies where runoff channelizes in intermittent flow and vegetation is to be established. Some products may have limited applicability in projects adjacent to navigable waters.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of erosion mat. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements. To complete the shear calculations, a 2 year, 24 hour storm event shall be used to calculate depth of flows for an ECRM. For sizing a TRM, use the depth of flow corresponding to the maximum design capacity of the channel.

Only mats listed in the Wisconsin Department of Transportation (WisDOT) Erosion Control Product Acceptability List (PAL) will be accepted for use in this standard.

To differentiate applications WisDOT organizes erosion mats into three classes of mats, which are further broken down into various Types.

A. **Class I**: A short-term duration (minimum of 6 months), light duty, organic ECRM with plastic or biodegradable netting.

   1. **Type A** – Only suitable for slope applications, not channel applications.

   2. **Type B** – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft^2 or less.

B. **Class II**: A long-term duration (three years or greater), organic ECRM.

   1. **Type A** – Jute fiber only for use in channels to reinforce sod.

   2. **Type B** – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Made with plastic or biodegradable mat.

   3. **Type C** – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft^2 or less. Applicable

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

for use in environmentally sensitive areas where plastic netting is inappropriate.

C. **Class III**: A permanent 100% synthetic ECRM or TRM. Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.

1. **Type A** – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

2. **Type B** – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft^2 or less.

3. **Type C** – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft^2 or less.

4. **Type D** – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft^2 or less.

D. **Installation**

1. ECRM shall be installed after all topsoiling, fertilizing, liming, and seeding is complete.

2. Erosion mats shall extend for whichever is greater: upslope one-foot minimum vertically from the ditch bottom or 6 inches higher than the design flow depth.

3. The mat shall be in firm and continuous contact with the soil. It shall be anchored, overlapped, staked and entrenched per the manufacturer's recommendations.

4. TRM shall be installed in conjunction with the topsoiling operation and shall be followed by ECRM installation.

5. At time of installation, document the manufacturer and mat type by saving material labels and manufacturer's installation instructions. Retain this documentation until the site is stabilized.

VI. Considerations

A. Erosion mats shall be selected so that they last long enough for the grass or other vegetation to become densely established.

B. Consider using Class II, Type C mats adjacent to waterways where trapping small animals is to be avoided.

C. Class III TRM may be appropriate as a replacement for riprap as a channel liner. Check the shear stress criteria for the channel to determine mat applicability.

D. Once a gully has formed in a channel, it is difficult to stabilize due to loss of soil structure. Even when the gully is filled with topsoil and reseeded, the soil has a tendency to dislodge in the same pattern. If gully formation continues to be a problem the design should be reevaluated, including other mat classes or riprap.

E. It may be difficult to establish permanent vegetation and adequate erosion protection in a channel with continuous flow. Consider riprap or planting wetland species with an ECRM.

F. Documentation of materials used, monitoring logs, project diary, and weekly inspection forms including erosion and stormwater management plans, should be provided to the authority charged with long term maintenance of the site.

G. Channel cross sections may be parabolic, v-shaped or trapezoidal. The use of "V" channels is generally discouraged due to erosion problems experienced.

H. To help determine the appropriate channel liner, designers can refer to the design matrix in the back of the WisDOT PAL. However, for channels not conforming to the typical section shown in the channel matrix or having a depth of flow greater than 6 inches (150 mm), the designer will need to design

for an appropriate channel liner. One way to do this is to use the "tractive force" method presented in FHWA's Hydraulic Engineering Circular (HEC) No. 15. This method requires that the calculated maximum shear stress of a channel is not to exceed the permissible shear stress of the channel liner. To use this method, permissible shear stress values are stated next to each device listed in the channel matrix.

VII. Plans and Specifications

A. Plans and specifications for installing erosion mat shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall address the following:

   1. Location of erosion mat
   2. Installation sequence
   3. Material specification conforming to standard

B. All plans, standard detail drawings, or specifications shall include schedule for installation, inspection, and maintenance. The responsible party shall be identified.

VIII. Operation and Maintenance

A. Erosion mats shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.

B. If there are signs of rilling under the mat, install more staples or more frequent anchoring trenches. If rilling becomes severe enough to prevent establishment of vegetation, remove the section of mat where the damage has occurred. Fill the eroded area with topsoil, compact, reseed and replace the section of mat, trenching and overlapping ends per manufacturer's recommendations. Additional staking is recommended near where rilling was filled.

C. If the reinforcing plastic netting has separated from the mat, remove the plastic and if necessary replace the mat.

D. Maintenance shall be completed as soon as possible with consideration to site conditions.

IX. References

WisDOT "Erosion Control Product Acceptability List" is available online at http://www.dot.wisconsin.gov/business/engrserv/pal.htm.

X. Definitions

Channel Erosion: The deepening and widening of a channel due to soil loss caused by flowing water. As rills become larger and flows begin to concentrate, soil detachment occurs primarily as a result of shear.

Erosion Control Revegative Mats (*ECRM)* (II): Erosion control revegetative mats are designed to be placed on top of soil.

Turf-Reinforcement Mats (*TRM)* (II): Turf-reinforcement mats are permanent devices constructed from various types of synthetic materials and buried below the surface to help stabilize the soil. TRMs must be used in conjunction with an ECRM or an approved soil stabilizer Type A (as classified in the WisDOT PAL)

Silt Fence
(1056)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

Silt fence is a temporary sediment barrier of entrenched permeable geotextile fabric designed to intercept and slow the flow of sediment-laden sheet flow runoff from small areas of disturbed soil.

II. Purpose

The purpose of this practice is to reduce slope length of the disturbed area and to intercept and retain transported sediment from disturbed areas.

III. Conditions Where Practice Applies

A. This standard applies to the following applications:

1. Erosion occurs in the form of *sheet and rill erosion*[1]. There is no concentration of water flowing to the barrier (*channel erosion*).

2. Where adjacent areas need protection from sediment-laden runoff.

3. Where effectiveness is required for one year or less.

4. Where conditions allow for silt fence to be properly entrenched and staked as outlined in the Criteria Section V.

B. Under no circumstance shall silt fence be used in the following applications:

1. Below the ordinary high watermark or placed perpendicular to flow in streams, swales, ditches or any place where flow is concentrated.

2. Where the maximum gradient upslope of the fence is greater than 50% (2:1).

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of silt fence. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements.

A. Placement

1. When installed as a stand-alone practice on a slope, silt fence shall be placed on the contour. The parallel spacing shall not exceed the maximum slope lengths for the appropriate slope as specified in Table 1.

Table 1.	
Slope	**Fence Spacing**
< 2%	100 feet
2 to 5%	75 feet
5 to 10%	50 feet
10 to 33%	25 feet
> 33%	20 feet

2. Silt fences shall not be placed perpendicular to the contour.

3. The ends of the fence shall be extended upslope to prevent water from flowing around the ends of the fence.

B. Height – Installed silt fences shall be a minimum 14 inches high and shall not exceed 28 inches in height measured from the installed ground elevation.

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

C. Support – Silt fences shall be supported by either steel or wood supports as specified below:

1. Wood supports

   a. The full height of the silt fence shall be supported by 1 1/8 inches by 1 1/8 inches air or kiln dried posts of hickory or oak.

   b. The silt fence fabric shall be stapled, using at least 0.5-inch staples, to the upslope side of the posts in at least 3 places.

   c. The posts shall be a minimum of 3 feet long for 24-inch silt fence and a minimum of 4 feet for 36-inch silt fence fabric.

2. Steel supports

   a. The full height of the silt fence shall be supported by steel posts at least 5 feet long with a strength of 1.33 pounds per foot and have projections for the attachment of fasteners.

   b. The silt fence fabric shall be attached in at least three places on the upslope side with 50 pound plastic tie straps or wire fasteners. To prevent damage to the fabric from fastener, the protruding ends shall be pointed away from the fabric.

3. The maximum spacing of posts for non-woven silt fence shall be 3 feet and for woven fabric 8 feet.

4. Silt fence shall have a support cord.

5. Where joints are necessary, each end of the fabric shall be securely fastened to a post. The posts shall then be wrapped around each other to produce a stable, secure joint or shall be overlapped the distance between two posts.

6. A minimum of 20 inches of the post shall extend into the ground after installation.

D. Anchoring – Silt fence shall be anchored by spreading at least 8 inches of the fabric in a 4 inch wide by 6 inch deep trench, or 6 inch deep V-trench on the upslope side of the fence. The trench shall be backfilled and compacted. Trenches shall not be excavated wider and deeper than necessary for proper installation.

On the terminal ends of silt fence the fabric shall be wrapped around the post such that the staples are not visible.

E. Geotextile Fabric Specifications – The geotextile fabric consists of either woven or non-woven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. Non-woven fabric may be needle punched, heat bonded, resin bonded, or combinations thereof. All fabric shall meet the following requirements as specified in Table 2.

Table 2.

Test Requirement	Method	Value[1]
Minimum grab tensile strength in the machine direction	ASTM D 4632	120 lbs. (550 N)
Minimum grab tensile strength in the cross machine direction	ASTM D 4632	100 lbs. (450 N)
Maximum apparent opening size equivalent standard sieve	ASTM D 4751	No. 30 (600 μm)
Minimum permittivity	ASTM D 4491	0.05 scc^{-1}
Minimum ultraviolet stability percent of strength retained after 500 hours of exposure	ASTM D 4355	70%

(WisDOT Standard Specifications for Road and Bridge Construction, 2001)

[1] All numerical values represent minimum / maximum average roll values. (For example, the average minimum test results on any roll in a lot should meet or exceed the minimum specified values.)

Silt fence shall have a maximum flow rate of 10-gallons/minute/square foot at 50mm constant head as determined by multiplying permittivity in 1/second as determined by ASTM D-4491 by a conversion factor of 74.

F. Removal – Silt fences shall be removed once the disturbed area is permanently stabilized and no longer susceptible to erosion.

VI. Considerations

A. Improper placement as well as improper installation and maintenance of silt fences will significantly decrease the effectiveness of this practice.

Silt fences should be considered for trapping sediment where sheet and rill erosion may be expected to occur in small drainage areas. Silt fences should not be placed in areas of concentrated flow.

B. Silt fences should be installed prior to disturbing the upslope area.

C. Silt fences should not be used to define the boundaries of the entire project. Silt fence should be placed only in areas where it is applicable due to its cost and the fact that it is not biodegradable. For example, silt fence should not be placed in locations where the natural overland flow is from an undisturbed area into disturbed areas of the project. It should also not be used as a diversion.

D. Silt fence should not be used in areas where the silt fence is at a higher elevation than the disturbed area.

E. When placing silt fence near trees, care should be taken to minimize damage to the root system. Avoid compaction and root cutting within 1.5 feet multiplied by the inch diameter of the tree (for example: for 10-inch trees keep out a 15-foot radius from the trunk). Refer to UWEX publication Preserving Trees During Construction for more information.

F. To protect silt fence from damage in areas of active construction or heavy traffic, silt fence should be flagged, marked, or highlighted to improve visibility.

G. Silt fence effectiveness is generally increased when used in conjunction with other upslope erosion control practices. To further strengthen the silt fence, straw / hay bales can be placed on the down slope side.

H. To help ensure effectiveness, silt fence should be inspected and repaired as necessary prior to forecasted rain events.

I. Where installation with wood posts is difficult, such as when hard or frozen ground is encountered, the use of steel post is recommended.

J. Silt fence can be mechanically installed with a plow type device provided that the silt fence is trenched in a manner such that equivalent performance is achieved to that specified in Section V.D.

VII. Plans and Specifications

A. Plans and specifications for installing silt fence shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall address the following:

1. Location of silt fence
2. Contributory drainage area
3. Schedules
4. Material specification conforming to standard
5. Standard drawings and installation details
6. Restoration after removal

B. All plans, standard detail drawings, or specifications shall include schedule for installation, inspection, and maintenance. The responsible party shall be identified.

VIII. Operation and Maintenance

A. Silt fences shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24 hour period.

B. Damaged or decomposed fences, undercutting, or flow channels around the end of barriers shall be repaired or corrected.

C. Sediment shall be properly disposed of once the deposits reach ½ the height of the fence.

IX. References

UWEX Publication A0327 “Preserving Trees During Construction”

X. Definitions

Channel Erosion (III.A.1): The deepening and widening of a channel due to soil loss caused by flowing water. As rills become larger and flows begin to concentrate, soil detachment occurs primarily as a result of shear.

Sheet and Rill Erosion (III.A.1): Sheet and rill erosion is the removal of soil by the action of rainfall and shallow overland runoff. It is the first stage in water erosion. As flow becomes more concentrated rills occur. As soil detachment continues or flow increases, rills will become wider and deeper forming gullies.

Stone Tracking Pad and Tire Washing
(1057)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A stabilized pad of stone aggregate or tire washing station located at any point where traffic will egress a construction site.

II. Purpose

The purpose of this standard is to reduce off-site sedimentation by eliminating the tracking of sediment from construction sites.

III. Conditions Where Practice Applies

Either a stone tracking pad or tire washing station shall be used at all points of construction egress. This standard applies where construction traffic is likely to transport sediment off site.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of this practice. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements.

A. Tracking Pad:

1. The tracking pad shall be installed prior to any traffic leaving the site

2. The aggregate for tracking pads shall be 3 to 6 inch clear or washed stone. All material to be retained on a 3-inch sieve.

3. The aggregate shall be placed in a layer at least 12 inches thick. On sites with a high water table, or where saturated conditions are expected during the life of the practice, stone tracking pads shall be underlain with a WisDOT Type R geotextile fabric to prevent migration of underlying soil into the stone.

4. The tracking pad shall be the full width of the egress point. The tracking pad shall be at a minimum 50 feet long.

5. Surface water must be prevented from passing through the tracking pad. Flows shall be diverted away from tracking pads or conveyed under and around them by using a variety of practices, such as culverts, *water bars*[1], or other similar practices.

B. Tire washing: If conditions on the site are such that the sediment is not removed from vehicle tires by the tracking pad, then tires shall be washed utilizing pressurized water before entering a public road.

1. The washing station shall be located on-site in an area that is stabilized and drains into suitable sediment trapping or settling device.

2. The wash rack shall consist of a heavy grating over a lowered area. The rack shall be strong enough to support the vehicles that will cross it.

C. Rocks lodged between the tires of dual wheel vehicles shall be removed prior to leaving the construction site.

[1] Words in the standard that are shown in italics are described in IX. Definitions. The words are italicized the first time they are used in the text.

VI. Considerations

A. Vehicles traveling across the tracking pad should maintain a slow constant speed.

B. The best approach to preventing off-site tracking is to restrict vehicles to stabilized areas.

C. It is always preferable to prevent sediment from being deposited upon the road than cleaning the road later. Sediment on a road can create a safety hazard as well as a pollution problem.

D. Any sediment tracked onto a public or private road should be removed by street cleaning, not flushing, before the end of each working day.

VII. Plans and Specifications

A. Plans and specifications for installing tracking pads shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall address the following:

   1. Location of all points of egress with tracking pad locations shown

   2. Material specifications conforming to standard

   3. Schedule for installation and removal

   4. Standard drawings and installation details

   5. Stabilization after removal

B. All plans, standard detail drawings, or specifications shall include schedule for installation, inspection, and maintenance. The responsible party shall be identified.

VIII. Operation and Maintenance

A. Tracking pads and tire washing stations shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.

B. The tracking pad performance shall be maintained by scraping or top-dressing with additional aggregate.

C. A minimum 12-inch thick pad shall be maintained.

IX. Definitions

Water bar (V.A.5): A shallow trench or diversion dam that diverts surface water runoff into a dispersion area.

Seeding For Construction Site Erosion Control
(1059)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

Planting seed to establish temporary or permanent vegetation for erosion control.

II. Purpose

The purpose of *temporary seeding*[1] is to reduce runoff and erosion until permanent vegetation or other erosion control practices can be established. The purpose of *permanent seeding* is to permanently stabilize areas of exposed soil.

III. Conditions Where Practice Applies

This practice applies to areas of exposed soil where the establishment of vegetation is desired. Temporary seeding applies to disturbed areas that will not be brought to final grade or on which land-disturbing activities will not be performed for a period greater than 30 days, and requires vegetative cover for less than one year. Permanent seeding applies to areas where perennial vegetative cover is needed.

IV. Federal, State and Local Laws

Users of this standard shall be aware of all applicable federal, state and local laws, rules, regulations or permit requirements governing seeding. This standard does not contain the text of federal, state or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements.

A. Site and Seedbed Preparation

Site preparation activities shall include:

1. Temporary Seeding

   a. Temporary seeding requires a seedbed of loose soil to a minimum depth of 2 inches.

   b. Fertilizer application is not generally required for temporary seeding. However, any application of fertilizer or lime shall be based on soil testing results.

   c. The soil shall have a pH range of 5.5 to 8.0.

2. Permanent Seeding

   a. *Topsoil* installation shall be completed prior to permanent seeding.

   b. Permanent seeding requires a seedbed of loose topsoil to a minimum depth of 4 inches with the ability to support a *dense* vegetative cover.

   c. Application rates of fertilizer or lime shall be based on soil testing results.

   d. Prepare a tilled, fine, but firm seedbed. Remove rocks, twigs foreign material and clods over two inches that cannot be broken down.

   e. The soil shall have a pH range of 5.5 to 8.0.

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

B. Seeding

1. Seed Selection

   a. Seed mixtures that will produce dense vegetation shall be selected based on soil and site conditions and intended final use. Section IX References, lists sources containing suggested seed mixtures.

   b. All seed shall conform to the requirements of the Wisconsin Statutes and of the Administrative Code Chapter ATCP 20.01 regarding noxious weed seed content and labeling.

   c. Seed mixtures that contain potentially invasive species or species that may be harmful to native plant communities shall be avoided.

   d. Seed shall not be used later than one year after the test date that appears on the label.

   e. Seed shall be tested for purity, germination and noxious weed seed content and shall meet the minimum purity and germination requirements as prescribed in the current edition of Rules for Testing Seed, published by the Association of Official Seed Analysts.

2. Seed Rates

   a. Temporary Seeding (Cover Crop)

      Areas needing protection during periods when permanent seeding is not applied shall be seeded with annual species for temporary protection. See Table 1 for seeding rates of commonly used species. The residue from this crop may either be incorporated into the soil during seedbed preparation at the next permanent seeding period or left on the soil surface and the planting made as a no-till seeding.

Table 1 Temporary Seeding Species and Rates

Species	Lbs/Acre	Percent Purity
Oats	131[1]	98
Cereal Rye	131[2]	97
Winter wheat	131[2]	95
Annual Ryegrass	80[2]	97

[1] Spring and summer seeding
[2] Fall seeding

   b. Permanent Seeding

      Rates shall be based on pounds or ounces of Pure Live Seed (PLS) per acre. Section IX contains some possible reference documents that provide seeding rates. Permanent seeding rates may be increased above the minimum rates shown in the reference documents to address land use and environmental conditions.

      If a *nurse crop* is used in conjunction with permanent seeding, the nurse crop shall not hinder establishment of the permanent vegetation.

      A nurse crop shall be applied at 50% its temporary seeding rate when applied with permanent seed.

3. Inoculation

   Legume seed shall be inoculated in accordance with the manufacturer's recommendations. Inoculants shall not be mixed with liquid fertilizer.

4. Sowing

   Seed grasses and legumes no more than ¼ inch deep. Distribute seed uniformly. Mixtures with low seeding rates require special care in sowing to achieve proper seed distribution.

   Seed may be broadcast, drilled, or hydroseeded as appropriate for the site.

   Seed when soil temperatures remain consistently above 53° F. *Dormant seed* when the soil temperature is consistently below 53° F (typically

Nov. 1st until snow cover). Seed shall not be applied on top of snow.

VI. Considerations

A. Consider seeding at a lower rate and making two passes to ensure adequate coverage.

B. Compacted soil areas may need special site preparation prior to seeding to mitigate compaction. This may be accomplished by chisel plowing to a depth of 12 inches along the contour after heavy equipment has left the site.

C. Sod may be considered where adequate watering is available.

D. When working in riparian areas refer to the NRCS Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection and Chapter 18, *Soil Bioengineering* for Upland Slope Protection and Erosion Reduction.

E. A site assessment should be conducted to evaluate soil characteristics, topography, exposure to sunlight, proximity to natural plant communities, proximity to nuisance, noxious and/or invasive species, site history, moisture regime, climatic patterns, soil fertility, and previous herbicide applications.

F. Use *introduced species* only in places where they will not spread into existing natural areas.

G. Lightly roll or compact the area using suitable equipment when the seedbed is judged to be too loose, or if the seedbed contains clods that might reduce seed germination.

H. See Section IX. References for suggested seed mixes (NRCS, WisDOT, UWEX) or use their equivalent.

I. Turf seedlings should not be mowed until the stand is at least 6 inches tall. Do not mow closer than 3 inches during the first year of establishment.

J. Seeding should not be done when the soil is too wet.

K. Consider watering to help establish the seed. Water application rates shall be controlled to prevent runoff and erosion.

L. Prairie plants may not effectively provide erosion control during their establishment period without a nurse crop.

M. Topsoil originating from agricultural fields may contain residual chemicals. The seedbed should be free of residual herbicide or other contaminants that will prevent establishment and maintenance of vegetation. Testing for soil contaminants may be appropriate if there is doubt concerning the soil's quality.

N. Consider using mulch or a nurse crop if selected species are not intended for quick germination. When mulching refer to WDNR Conservation Practice Standard Mulching for Construction Sites (1058).

VII. Plans and Specifications

Plans and specifications for seeding shall be in keeping with this standard and shall describe the requirements for applying this practice.

All plans, standard detail drawings, or specifications shall include schedule for installation, inspection, and maintenance. The responsible party shall be identified.

VIII. Operation and Maintenance

A. During construction areas that have been seeded shall at a minimum be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period. Inspect weekly during the growing season until vegetation is densely established or permit expires. Repair and reseed areas that have erosion damage as necessary.

B. Limit vehicle traffic and other forms of compaction in areas that are seeded.

C. A fertilizer program should begin with a soil test. Soil tests provide specific fertilizer recommendations for the site and can help to avoid over-application of fertilizers.

IX. References

A. Seed Selection References

United States Department of Agriculture – Natural Resource Conservation Service Field Office Technical Guide Section IV, Standard 342, Critical Area Planting.

UWEX Publication A3434 Lawn and Establishment & Renovation.

WisDOT, 2003. State of Wisconsin Standard Specifications For Highway and Structure Construction. Section 630, Seeding.

B. General References

Association of Official Seed Analysts, 2003. Rules for Testing Seed. http://www.aosaseed.com.

Metropolitan Council, 2003. Urban Small Sites Best Management Practice Manual, Chapter 3, Vegetative Methods 3-85 – 3-91. Minneapolis.

The State of Wisconsin list of noxious weeds can be found in Statute 66.0407.

United States Department of Agriculture – Natural Resources Conservation Service. Engineering Field Handbook, Chapters 16 and 18.

UWEX Publication GWQ002 Lawn & Garden Fertilizers.

X. Definitions

Dense (V.A.2.b) A stand of 3-inch high grassy vegetation that uniformly covers at least 70% of a representative 1 square yard plot.

Dormant seed (V.B.4): Seed is applied after climatic conditions prevent germination until the following spring.

Introduced Species (VI.F) Plant species that historically would not have been found in North America until they were brought here by travelers from other parts of the world. This would include smooth bromegrass and alfalfa. Some of these species may have a wide distribution such as Kentucky bluegrass.

Nurse Crop (V.B.2.b): Also known as a companion crop; is the application of temporary (annual) seed with permanent seed.

Permanent seeding (II) Seeding designed to minimize erosion for an indefinite period after land disturbing construction activities have ceased on the site.

Soil Bioengineering (VI.D) Practice of combining mechanical, biological and ecological concepts to arrest and prevent shallow slope failures and erosion.

Temporary Seeding (II) Seeding designed to control erosion for a time period of one year or less that is generally removed in order to perform further construction activities or to permanently stabilize a construction site.

Topsoil (V.A.2.a) Consists of loam, sandy loam, silt loam, silty clay or clay loam humus-bearing soils adapted to sustain plant life with a pH range of 5.5 – 8.0. Manufactured topsoil shall through the addition of sand or organic humus material, peat, manure or compost meet the above criteria.

Storm Drain Inlet Protection for Construction Sites
(1060)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A temporary device installed in or around a storm drain inlet, drop inlet, or curb inlet.

II. Purposes

This practice is intended to minimize sediment from entering storm drainage systems in areas where the contributing drainage area is temporarily disturbed.

III. Conditions Where Practice Applies

This practice applies where runoff from construction sites enters conveyance system structures, such as drain inlets, drop inlets, and curb inlets. Inlet protection devices are for drainage areas of one acre or less. Runoff from areas larger than one acre shall be routed through a properly designed sediment trapping or settling practice upstream of the inlet.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state and local laws, rules, regulations, or permit requirements governing the use and placement of storm drain inlet protection. This standard does not contain the text of federal, state, or local laws.

V. Design Criteria

This section establishes the minimum standards for design, installation, and performance requirements.

The appropriate type of inlet protection shall be installed prior to drain, drop, or curb inlet receiving runoff. The device shall remain in place and be maintained until the disturbed area is stabilized.

A. General Criteria Applicable to All Inlet Protection Devices

1. Ponding water to settle sediment is encouraged; however ponding shall not interfere with the flow of traffic, create a safety hazard, or cause property damage. All devices shall have provisions such as overflow holes or "emergency spillways" to safely pass water if the device becomes clogged.

2. The contributing drainage area to the inlet protection device shall be one acre or less. In instances where a larger contributing drainage area exists, runoff shall be routed through a properly designed sediment trapping or settling practice upstream of the inlet.

3. No gaps shall be left in the material that would allow the flow of water to bypass the inlet protection device, except for overflow holes.

4. All fabrics used as part of Type A, B, C, D, D-M and D-HR inlet protection devices must meet WisDOT specifications for the selected fabric.

5. Type FF geotextile fabric shall be used for Type, A, B, C or D inlet protection.

6. Type D-M inlet protection fabric shall be Type FF for both the upper section and the outer lower sections of the device. The replaceable interior filter fabric type shall be based according to the particle size trapped. Refer to Table 1 for the filter fabric type and exposed soil particle diameter where the device is appropriate.

7. Type D-HR inlet protection fabric shall be Type FF for the upper half of the device. Type HR fabric shall be used in the lower half of the device. Refer to Table 1 for filter fabric type and exposed soil texture and particle diameter where the device is appropriate.

Table 1			
Exposed Soil Texture	**Exposed Soil Particle Diameter (average) (mm)**	**Filtering Fabric Type***	**Recommended Inlet Protection Device Type**
Course (Sand)	≥ 0.0625	FF	D, D-M
Medium (Silt Loam)	0.0624 – 0.005	DF	D-M
Fine (Clay)	≤ 0.004	R	D-M
		HR	D-HR

* DF, R or HR filters may be used where FF is the required minimum standard. R or HR filers may be used where DF is the required minimum standard.

B. Criteria Applicable to Inlet Protection Devices for Unpaved Areas or the Pre-Paving Phase of Construction

1. Inlet protection (all device types) - See Figures 1-3.

   a. Type A devices shall be utilized around inlets in unpaved areas and should be maintained until permanent stabilization has been established. Type A devices shall be utilized on inlets prior to installation of curb and gutter or pavement and where safety considerations are not compromised on the site.

   b. Type B and C devices shall be utilized after the casting and grate are in place and may only be utilized when sufficient depth is not available to use Type D, D-M, or D-HR devices.

   c. Inlet protection Type D-M and D-HR devices shall only be used after castings are in place on top of the inlet boxes.

      Type D, D-M, and D-HR devices shall conform to the standard drawings as shown in the figures. To prevent the filter bag from blocking overflow water, there shall be three inches of clearance between the bag and the sides of the inlet. Type D, D-M and D-HR devices when used in inlets less than 30 inches in depth shall have the filter bag cinched to provide the required clearance for overflow.

2. Other inlet protection devices include, but are not limited to: straw bales, rock bags and stone weepers. These devices can be used to settle sediment or divert flow. Note: these devices are not applicable to areas adjacent to traffic.

C. Criteria Applicable to Inlet Protection Devices for the Post-Paving / Curbing Phase of Construction

1. Inlet protection Types B, C, D, D-M, and D-HR are applicable to post-paving construction. See Figures 1-3.

   a. Type B devices shall be utilized on inlets without a curb box when Type D inlet devices cannot be used.

   b. Type C devices shall be utilized on street inlets with curb heads. A 2-inch by 4-inch (nominal) piece of wood shall be wrapped and secured in the fabric and placed in front of the curb head, as shown in the figures. The wood shall not block the entire opening of the curb box and shall be secured to the grate with wire or plastic ties. Use Type C devices when Type D devices cannot be used.

   c. Utilize Type D, D-M, and D-HR devices when the depth from the top of the grate to the bottom of the inlet is 30 inches or greater. Note: Type D style devices can be modified by cinching the filter bag to fit inlet structures that are less than 30 inches in depth.

   d. Utilize Type D, D-M, and D-HR devices where street flooding or ponding water and the associated traffic safety issues are a concern, or where more effective inlet filtering is needed.

2 Other inlet protection devices are applicable to post paving construction; these devices include but are not limited to: rock bags, manufactured bags, and stone weepers. These devices can be used to either settle sediment or divert flow. Note: other than for internal to the inlet type filters these devices are not applicable to areas adjacent to traffic.

a. Manufactured rock bags shall conform to the WisDOT standard for rock bag material, including fill material.

b. Straw bale installation shall conform to the criteria outlined in the WDNR Conservation Practice Standard (1062) Ditch Check.

c. Stone weeper installation shall conform to the criteria in WDNR Conservation Practice Standard (1063) Sediment Trap.

VI. Considerations

A. Inlet protection is only one element in an erosion control plan. Other practices, including temporary stabilization and area clean up, should also be utilized upstream of the inlet.

B. Inlets should be temporarily closed or sealed to prevent entrance of runoff and sediment when site conditions allow.

C. The disturbed area should be stabilized as quickly as possible. Timely stabilization is the most effective method to control sediment entering the storm sewer.

D. Storm drain inlet protection consists of several different types of inlet filters and sediment traps. Inlet protection is only one element in an erosion control plan. Each type differs in application with selection dependent upon site conditions and inlet type. Not all designs are appropriate in all cases. The user must carefully select a design suitable for the needs and site conditions.

E. Inlet protection is only as effective as the filter or device used around the inlet. Effectiveness decreases rapidly if the inlet protection is not properly maintained. In general, inlet protection provides relatively good removal of coarse and medium-sized soil particles from runoff; however, to effectively trap fine soil particles, other practices such as the use of polyacramides, may be required. (See DNR technical standard 1050)

F. Inlet protection requires routine inspection and maintenance. Field inspections have shown where inlet protection causes excessive ponding that the device is removed, punctured, or bypassed. In such situations, a structure with an adequate overflow mechanism should be utilized instead of simply removing the inlet protection device.

G. The effectiveness of inlet protection devices in unpaved areas can be enhanced by additional excavation to increase the storage capacity around the inlet.

H. Good construction site housekeeping measures, such as maintaining clean gutters and street sweeping, are important.

I. The use of fabric intended for a finer soil type on a construction site with coarser soil may increase the required maintenance frequency due to faster clogging.

J. Consider using Type D-M and D-HR inlet protection rather than Type B, C, or D in areas with fine soils where more effective filtering is desired.

VII. Plans and Specifications

Plans and specifications for installing inlet protection shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose:

A. Locations and types of inlet protection.

B. Material specification conforming to this standard.

C. All construction documents shall identify the responsible party and include a schedule for installation, inspection, and maintenance requirements.

VIII. Operation and Maintenance

A. Remove inlet protection devices once the contributing drainage area is stabilized with appropriate vegetation or impervious surface.

B. Inlet protection shall be at a minimum inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.

C. For Type A, B or C inlet protection:

1. Remove sediment deposits when sediment has accumulated between ⅓ to ½ of the design depth or the device is no longer functioning as designed.
2. Inspect the device routinely, and repair (if necessary) and restore to original dimension.
3. Sediment removed from the device shall be deposited in a suitable area and stabilized.

D. For Type D and D-M inlet protection;

1. Remove sediment when it accumulates to within 6 inches of the bottom of the overflow holes.
2. If standing water remains within 6 inches of the bottom of the overflow holes 24 hours after a runoff event, accumulated sediment shall be removed and the filtering capacity of the fabric shall be restored.
3. Holes in the Type FF fabric less than 2 inches in length may be repaired by stitching. The bag must be replaced if holes greater than 2 inches are observed in the Type FF fabric.
4. The insert filter fabric shall be replaced if any holes are observed in the fabric.
5. The filter must be replaced if the flap pockets sustain damage that compromises the integrity of the filter or the ability to perform maintenance.

E. For Type D-HR inlet protection:

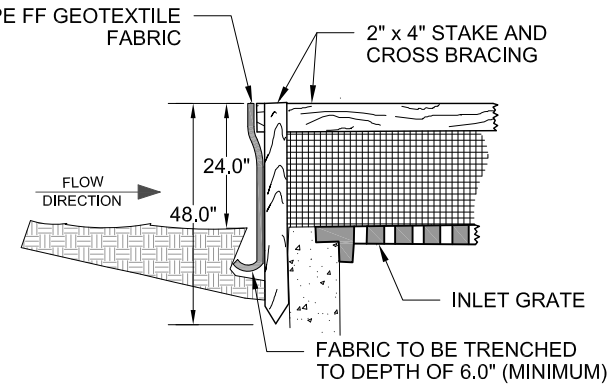
1. Remove sediment when it has accumulated to within 6 inches of the bottom of the overflow holes.
2. If standing water remains within 6 inches of the bottom of the overflow holes 24 hours after a runoff event, accumulated sediment shall be removed and the filtering capacity of the fabric shall be restored.
3. Holes in the Type FF fabric less than 2 inches in length may be repaired by stitching.
4. The filter shall be replaced if any holes are observed in the Type HR fabric or holes greater than 2 inches are observed in the Type FF fabric.
5. The filter must be replaced if the flap pockets sustain damage that compromises the integrity of the filter or the ability to perform maintenance.

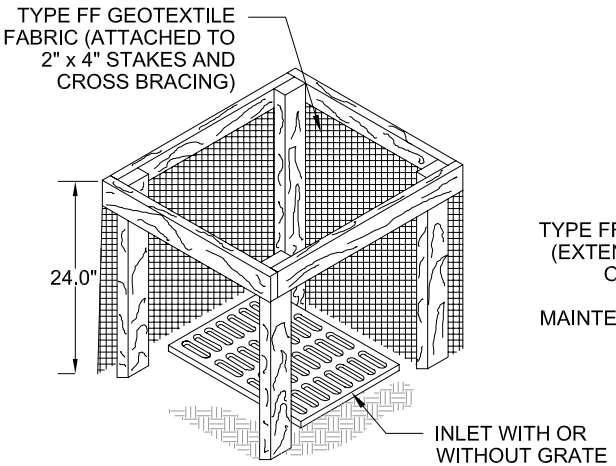
F. Due care shall be taken to minimize sediment falling into the inlet. Any material falling into the inlet shall be removed.

IX. References

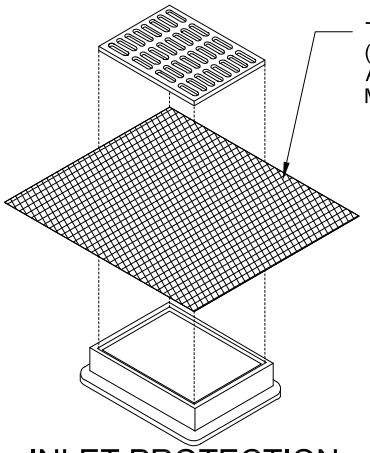
WisDOT "Standard Specifications for Highway and Structures Construction" is available at: http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

FIGURE 1. INLET PROTECTION TYPES A, B, C AND D

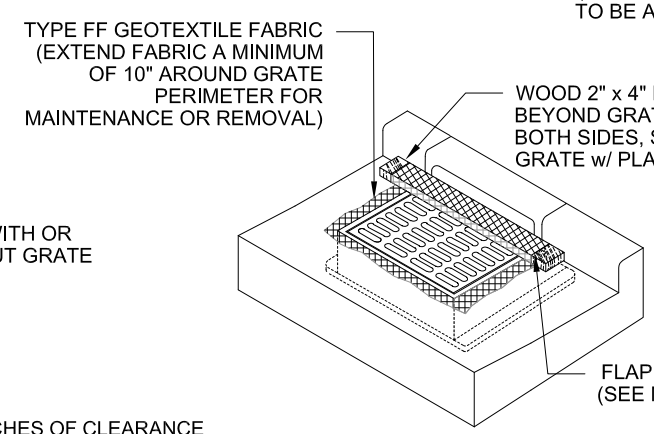




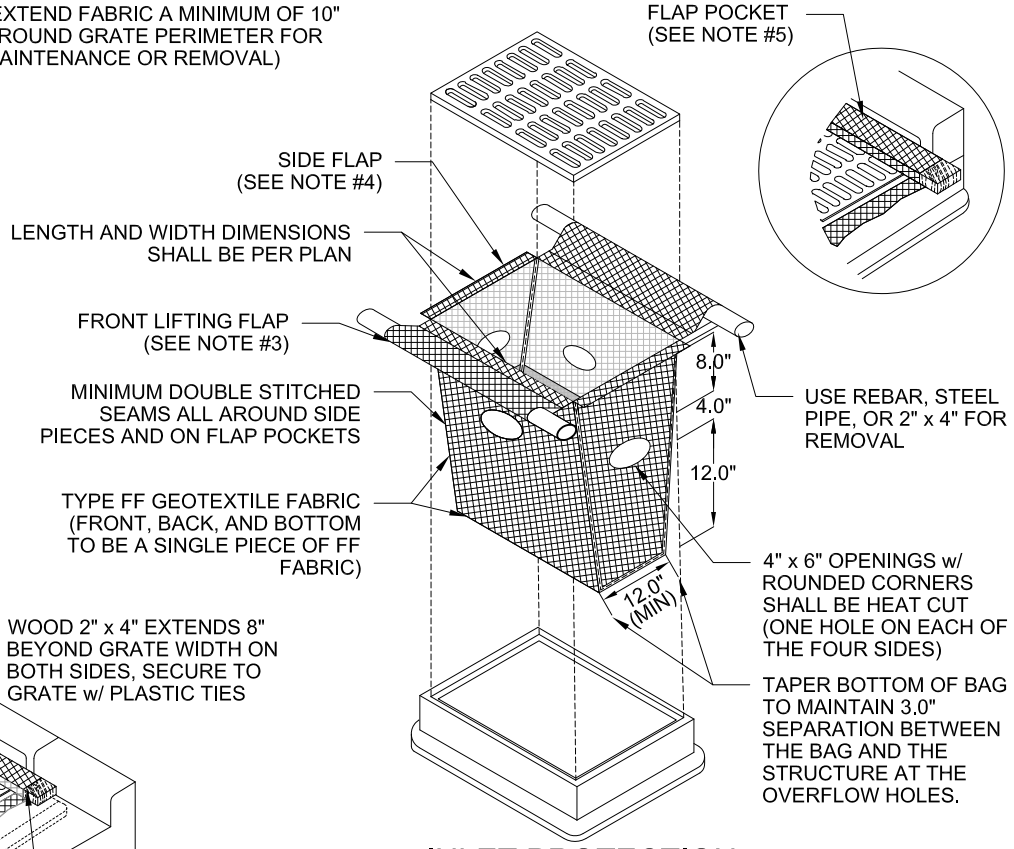
INLET PROTECTION
TYPE A



INLET PROTECTION
TYPE B
WITHOUT CURB BOX



INLET PROTECTION
TYPE C
WITH CURB BOX



INLET PROTECTION
TYPE D
CAN BE INSTALLED IN INLETS
WITH OR WITHOUT CURB BOXES

NOTES:

1. TAPER BOTTOM OF BAG TO MAINTAIN THREE INCHES OF CLEARANCE BETWEEN THE BAG AND THE STRUCTURE, MEASURED FROM THE BOTTOM OF THE OVERFLOW OPENINGS TO THE STRUCTURE WALL.
2. GEOTEXTILE FABRIC TYPE FF FOR FLAPS, TOP AND BOTTOM OF OUTSIDE OF FILTER BAG. FRONT, BACK, AND BOTTOM OF FILTER BAG BEING ONE PIECE.
3. FRONT LIFTING FLAP IS TO BE USED WHEN REMOVING AND MAINTAINING FILTER BAG.
4. SIDE FLAPS SHALL BE A MAXIMUM OF TWO INCHES LONG. FOLD THE FABRIC OVER AND REINFORCE WITH MULTIPLE STITCHES.
5. FLAP POCKETS SHALL BE LARGE ENOUGH TO ACCEPT WOOD 2" x 4". THE REBAR, STEEL PIPE, OR WOOD SHALL BE INSTALLED IN THE REAR FLAP AND SHALL NOT BLOCK THE TOP HALF OF THE CURB FACE OPENING.

MAINTENANCE NOTES:

1. WHEN REMOVING OR MAINTAINING INLET PROTECTION, CARE SHALL BE TAKEN SO THAT THE SEDIMENT TRAPPED IN THE FABRIC DOES NOT FALL INTO THE STRUCTURE. MATERIAL THAT HAS FALLEN INTO THE INLET SHALL BE IMMEDIATELY REMOVED.

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1060	TECHNICAL STANDARD No.
08/2014	REVISION DATE
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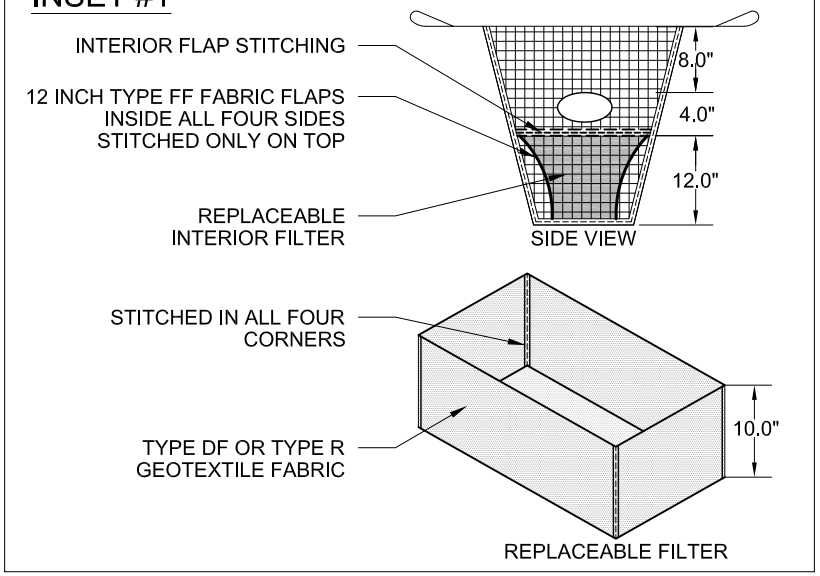
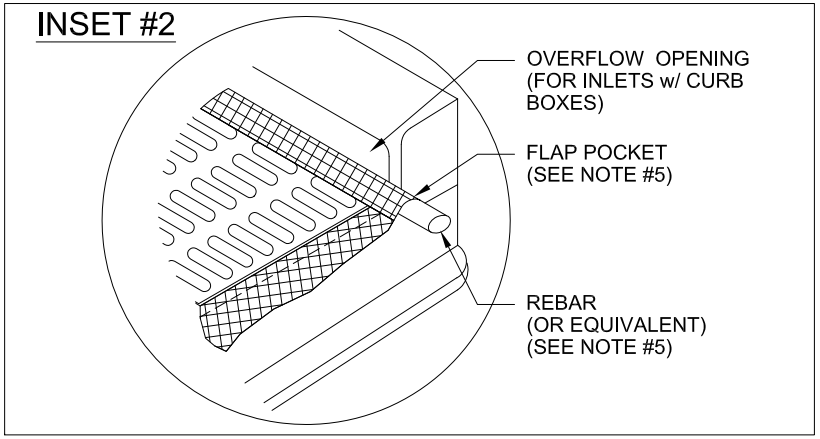
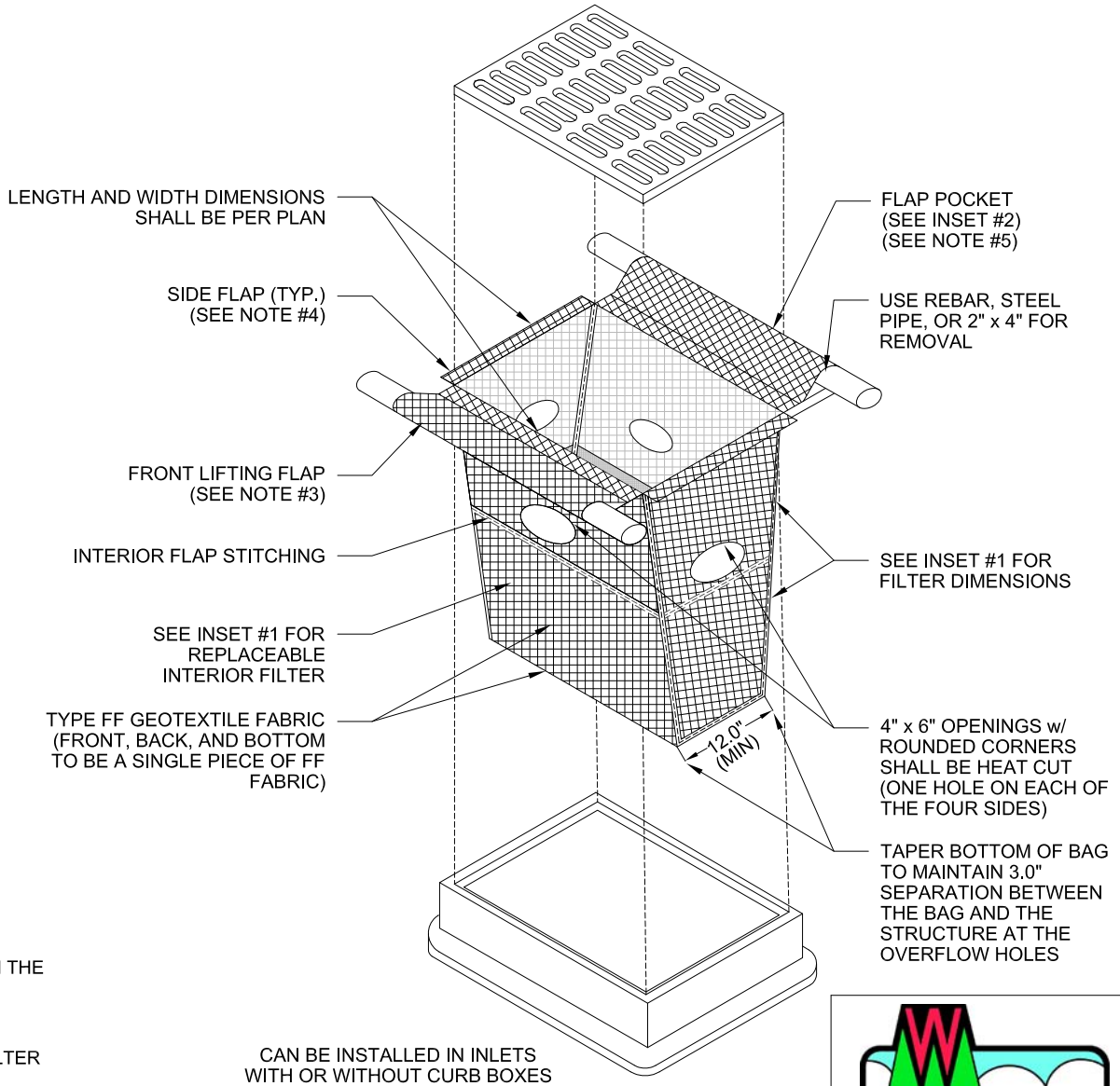
FIGURE 2. INLET PROTECTION TYPE D-M

INSET #1



INSET #2





CAN BE INSTALLED IN INLETS WITH OR WITHOUT CURB BOXES

NOTES:

1. TAPER BOTTOM OF BAG TO MAINTAIN THREE INCHES OF CLEARANCE BETWEEN THE BAG AND THE STRUCTURE, MEASURED FROM THE BOTTOM OF THE OVERFLOW OPENINGS TO THE STRUCTURE WALL.
2. GEOTEXTILE FABRIC TYPE FF FOR FLAPS, TOP AND BOTTOM OF OUTSIDE OF FILTER BAG. FRONT, BACK, AND BOTTOM OF FILTER BAG BEING ONE PIECE.
3. FRONT LIFTING FLAP IS TO BE USED WHEN REMOVING AND MAINTAINING FILTER BAG.
4. SIDE FLAPS SHALL BE A MAXIMUM OF TWO INCHES LONG. FOLD THE FABRIC OVER AND REINFORCE WITH MULTIPLE STITCHES.
5. FLAP POCKETS SHALL BE LARGE ENOUGH TO ACCEPT WOOD 2" x 4". THE REBAR, STEEL PIPE, OR WOOD SHALL BE INSTALLED IN THE REAR FLAP AND SHALL NOT BLOCK THE TOP HALF OF THE CURB FACE OPENING.

MAINTENANCE NOTES:

1. WHEN REMOVING OR MAINTAINING INLET PROTECTION, CARE SHALL BE TAKEN SO THAT THE SEDIMENT TRAPPED IN THE FABRIC DOES NOT FALL INTO THE STRUCTURE. MATERIAL THAT HAS FALLEN INTO THE INLET SHALL BE IMMEDIATELY REMOVED.

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1060	TECHNICAL STANDARD No.
08/2014	REVISION DATE
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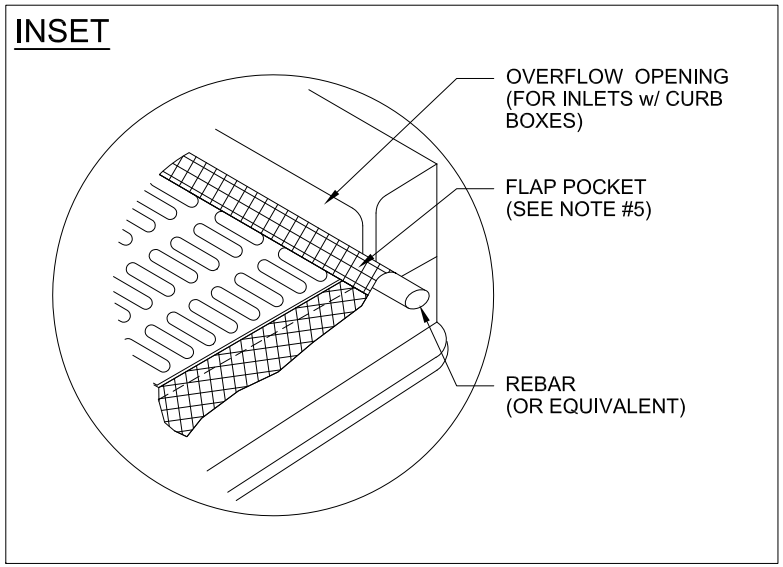
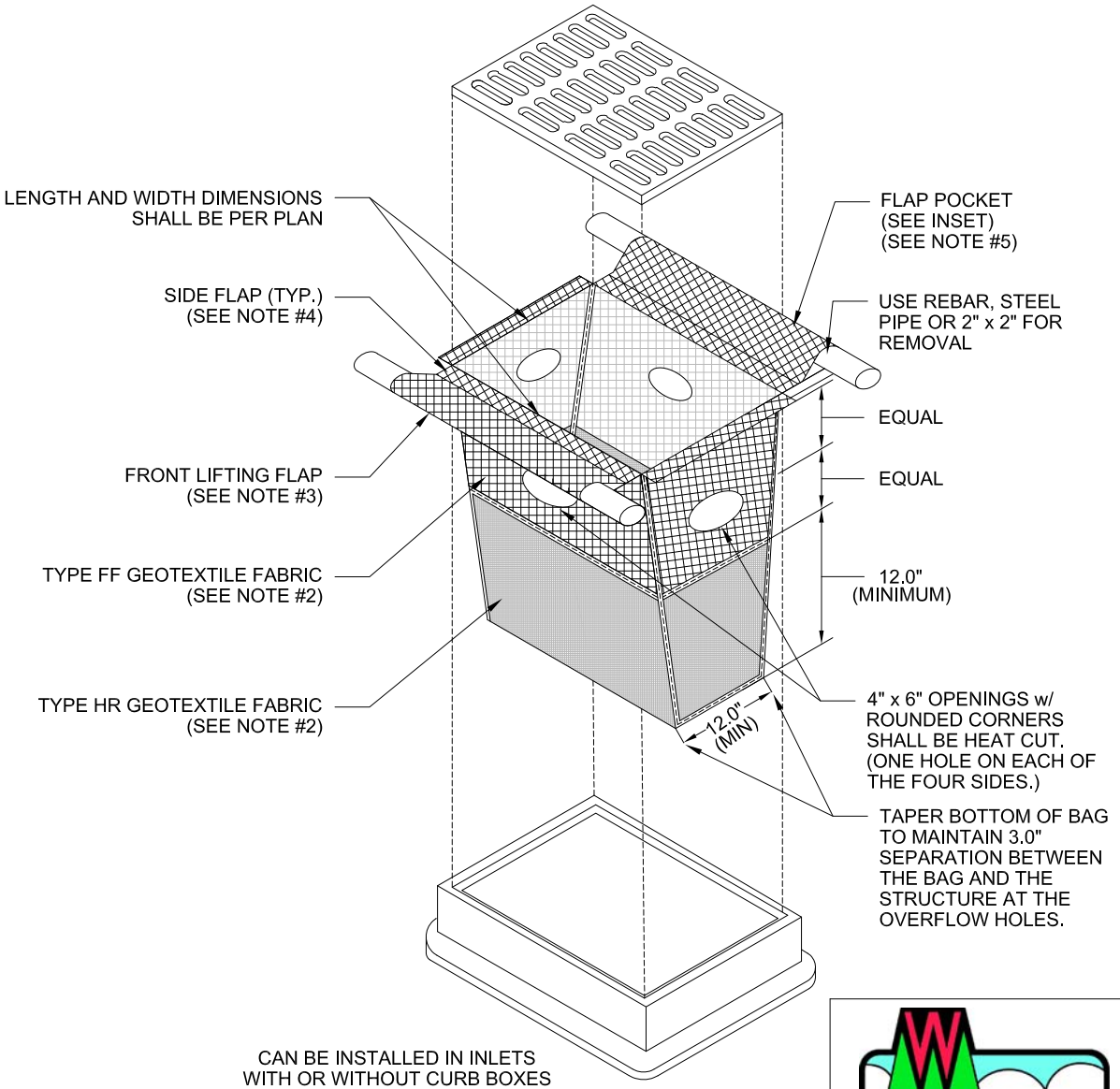
FIGURE 3. INLET PROTECTION TYPE D-HR





CAN BE INSTALLED IN INLETS
WITH OR WITHOUT CURB BOXES

NOTES:

1. TAPER BOTTOM OF BAG TO MAINTAIN THREE INCHES OF CLEARANCE BETWEEN THE BAG AND THE STRUCTURE, MEASURED FROM THE BOTTOM OF THE OVERFLOW OPENINGS TO THE STRUCTURE WALL.
2. GEOTEXTILE FABRIC, TYPE FF FOR FLAPS AND TOP HALF OF FILTER BAG. GEOTEXTILE FABRIC, TYPE HR FOR BOTTOM HALF OF FILTER BAG WITH FRONT, BACK, AND BOTTOM BEING ONE PIECE.
3. FRONT LIFTING FLAP IS TO BE USED WHEN REMOVING AND MAINTAINING FILTER BAG.
4. SIDE FLAPS SHALL BE A MAXIMUM OF TWO INCHES LONG. FOLD THE FABRIC OVER AND REINFORCE WITH MULTIPLE STITCHES.
5. FLAP POCKETS SHALL BE LARGE ENOUGH TO ACCEPT WOOD 2" x 2". THE REBAR, STEEL PIPE, OR WOOD SHALL BE INSTALLED IN THE REAR FLAP AND SHALL NOT BLOCK THE TOP HALF OF THE CURB FACE OPENING.

MAINTENANCE NOTES:

1. WHEN REMOVING OR MAINTAINING INLET PROTECTION, CARE SHALL BE TAKEN SO THAT THE SEDIMENT TRAPPED IN THE FABRIC DOES NOT FALL INTO THE STRUCTURE. MATERIAL THAT HAS FALLEN INTO THE INLET SHALL BE IMMEDIATELY REMOVED.

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1060	TECHNICAL STANDARD No.
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DEWATERING

Code No.
(1061)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A compartmented container, settling basin, filter, or other appropriate best management practice through which sediment-laden water is conveyed to trap and retain the sediment.

II. Purposes

The purpose of this standard is to determine appropriate methods and means to remove sediment from water generated during dewatering activities prior to discharging off-site or to waters of the state. Practices identified in this standard shall be deemed to meet the de-watering performance standard to prevent the discharge of sediment to the maximum extent practicable (MEP) as defined in NR 151.11(6)(c).

III. Conditions where Practice Applies

This practice applies where sediment laden water needs to be removed for construction or maintenance activities. Dewatering practices shall be in keeping with the effective operating and applicability criteria listed on Figure 2, Dewatering Practice Selection Matrix.

This practice does not apply to:

- Water being discharged directly to groundwater or *karst features*[1]. Refer to NR140.
- Well dewatering systems. Refer to NR 812.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of this practice. This may include activities performed under NR 216 and Chapter 30 permits, for water bodies with *targeted performance standards* per NR 151.004, 303d waterbodies or others. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum allowable limits for design parameters, installation and performance requirements.

Dewatering practices shall be selected based on the predominant soil texture encountered at the dewatering site with consideration given to pumping or flow rates, volumes and device effectiveness. Refer to Figure 1 USDA Soil textural triangle to assist with soil classifications at the site. Figure 2, Dewatering Practice Selection Matrix illustrates acceptable dewatering options and their effective ranges. Practices selected that are not on the matrix must provide an equivalent level of control, with justification provided to the reviewing authority.

A. Site Assessment - A site assessment shall be conducted and documented to determine the physical site characteristics that will affect the placement, design, construction and maintenance of dewatering activities. The site assessment shall identify characteristics such as ground slopes, soil types, soil conditions, bedrock, sinkholes, drainage patterns, runoff constituents, proximity to regulated structures, natural resources, and specific land uses. The site assessment shall include the following:

- Sanitary and storm sewer locations
- Potential contamination - Odor or discoloration other than sediment, or an oily sheen on the surface of the sediment laden water. If contamination is present, notify DNR Spills Reporting
- Soil textural class for areas where dewatering will occur. Soil investigation shall extend below grading and trenching activities
- Depth to the seasonally highest water table.
- Discharge outfall locations
- Distance and conveyance method to receiving waters

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

B. General Criteria applicable to all dewatering activities

1. Contact the WDNR when the discharge from a dewatering practice will enter a WDNR listed *Exceptional Resource Water (ERW), Outstanding Resource Water (ORW),* or a wetland in an area of special natural resource interest as identified in NR 103.

2. Contact the owner or operator of the municipal separate stormwater system if the discharge is to a municipal storm water conveyance system. The allowable discharge rate shall be limited by the capacity of the system or requirements of the system owner.

3. When practical, dewatering effluent shall be collected in a pump truck for transport to a *treatment facility* or discharged directly to a treatment facility.

4. For surface dewatering, utilize a floating suction hose, or other method, to minimize sediment being sucked off the bottom.

5. For discharges that will be directed to locations on-site verify that the anticipated volume of water can be fully contained.

6. The topography and condition of the ground cover between the pump discharge point and potential receiving waters shall be evaluated for potential erosion. Appropriate stabilization measures shall be incorporated to prevent erosion.

7. When discharge to a karst feature or other direct groundwater connection can not be avoided, the dewatering system must be designed and operated to maintain compliance with the groundwater quality standards contained in applicable regulations, including ch. NR 140 Wis. Adm. Code.

8. If the discharge directly or indirectly enters a stream, the discharge flow rate shall not exceed 50 percent of the peak flow rate of the 2-year 24-hour storm event.

C. Geotextile Bags

1. Geotextile bags shall meet the criteria listed in Table 1.

Table 1: Properties for Geotextile Bags

Property	Test Method	Type I Value	Type II Value
Maximum Apparent Opening Sizes	ASTM D-4751	0.212 mm	0.212 mm
Grab Tensile Strength	ASTM D-4632	200 lbs.	300 lbs.
Mullen Burst	ASTM D-3786	350 psi	580 psi
Permeability	ASTM D-4491	0.28 cm/sec	0.2 cm/sec
Fabric	Nominal Representative Weight	8 oz	12 oz

2. Geotextile bags shall be sized according to the particle size being trapped, expected flow or pumping rate (gallons per minute) per square foot of fabric and a 50% clogging factor. The footprint of the bag shall be no smaller than 100 square feet.

3. Geotextile bags shall be securely attached to the discharge pipe.

4. Polymers can be used to enhance the efficiency of geotextile bags. If polymer is used, the polymer shall be approved by the WDNR and meet the criteria stipulated in WDNR Conservation Practice Standard 1051, Sediment Control Water Application of Polymers. The polymer supplier or applicator shall provide certifications showing that products have met the performance requirements of Standard 1051. If the manufacturer has not completed the required testing, the project may be used to gain that certification provided it meets the site requirements of Standard 1051. Any such testing will be monitored by DNR or WisDOT, with testing done by a qualified third party.

D. Gravity Based Settling Systems

Gravity based systems rely on settling of particles as the primary means of treatment. To effectively accomplish this, quiescent conditions should exist with sufficient detention time. Practices include portable sediment tanks, sediment traps, sediment basins and wet detention basins.

If polymer is used to enhance settling, the polymer shall be approved by the WDNR and meet the criteria stipulated in WDNR Conservation Practice Standard 1051, Sediment Control Water Application of Polymers. The polymer supplier or applicator shall provide certifications showing that products have met the performance requirements of Standard 1051. If the manufacturer has not completed the required testing, the project may be used to gain that certification provided it meets the site requirements of Standard 1051. Any such testing will be monitored by DNR or WisDOT, with testing done by a qualified third party.

1. Portable Sediment Tank: These tanks are intended to settle only sands, loamy sands, and sandy loams. If polymer is added, these tanks will also be appropriate for settling loams, silt loams and silts. Portable sediment tanks shall have a minimum of two baffled compartments, and be a minimum of three feet deep. The inlet and outlet pipe shall be a minimum diameter of three inches. Use one of the following methods to size a tank:

    a. Settling: Account for settling of the suspended sediments with the following equation:

        Sa = 1.83 * Q;

        where

        Sa = Tank surface area (sq ft)
        Q = Pumping rate (gallons per minute)

        Note: 1.83 is a factor that includes the conversion from gpm to cfs (1 gpm = 0.0022 cfs) and the particle settling velocity for Soil Class 1 (0.0012 ft/sec) from WDNR Conservation Practice Standard 1064 Sediment Basin.

    b. Filtration: Build the first chamber as large as possible to aid in settling. Flow capacity shall be determined by the end area of the filter media (fabric) and the flow rate (gallons per minute) per square foot of the finest filter media and a 50% clogging factor.

2. Sediment Trap or Sediment Basin: This device is a temporary sediment control device. The design, installation, and operation of the sediment trap or basin shall meet the requirements stipulated in WDNR Conservation Practice Standard 1063 Sediment Trap or Standard 1064 Sediment Basin

3. Wet Detention Basin: This device is generally a permanent structure designed to address post-construction pollutant reduction requirements. The design, installation, and operation of the wet detention basin shall meet the requirements stipulated in WDNR Conservation Practice Standard 1001 Wet Detention Basin.

E. Passive Filtration Systems

Passive filtration systems rely on filtration as the primary method of removing particles. Sediment removal efficiency will be related to the particle size distribution in the stormwater. Practices include manufactured filters, filter tanks, filter basins, vegetative filters, grass swales, and filtration fabric.

Filter fabric sediment removal efficiency shall be based on the properties specified in Table 1.

1. Manufactured Filters: Filters shall be sequenced from the largest to the smallest pore opening. Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm.

2. Filter Tank (portable): Install, operate and maintain according to manufacturer recommendations.

3. Filter Basin: Install, operate and maintain according to Wisconsin Department of Transportation technical guidance.

4. Vegetative Filter: Refer to WDNR Conservation Practice Standard 1054 Vegetated Buffer for Construction Sites.

F. Pressurize Filtration Systems

Pressurized filtration systems differ from passive systems in that the water flowing through the media is pressurized and the filter media is designed to handle higher flow rates. Practices include portable sand filters, wound cartridge units, membranes and micro-filtration units.

Pressurized filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is small or substantially more turbid than the stormwater stored in the holding pond or tank, returning backwash water to the pond or tank may be appropriate. However, land application or another means of treatment and disposal may be necessary.

Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.

1. Portable Sand Filter: Install, operate and maintain according to manufacturer recommendations.

2. Wound Cartridge Units: Secondary filtration of sediments using high efficiency filter cartridges may be necessary to remove fine particles such as clays. Install, operate and maintain according to manufacturer recommendations.

3. Membranes and Micro-filtration: Install, operate and maintain according to manufacturer recommendations.

4. If polymer is used to enhance settling, the polymer shall be approved by the WDNR and meet the criteria stipulated in WDNR Conservation Practice Standard 1051, Sediment Control Water Application of Polymers. The polymer supplier or applicator shall provide certifications showing that products have met the performance requirements of Standard 1051. If the manufacturer has not completed the required testing, the project may be used to gain that certification provided it meets the site requirements of Standard 1051. Any such testing will be monitored by DNR or WisDOT, with testing done by a qualified third party.

VI. Considerations

A. It may be necessary to clean the municipal storm drainage system prior to and after discharging to the system to prevent scouring solids from the drainage system.

B. Geotextile bags are generally not appropriate when discharging to ORW, ERW, waterbodies supporting cold water communities, trout streams, or to *highly susceptible* and *less susceptible wetlands*.

C. Pressurized filtration systems are the most efficient for removing fine sediments.

D. Portable sediment tanks may be appropriate when other sediment trapping practices cannot be installed due to lack of space or other reasons.

E. Filtration is not an efficient treatment of water with heavy sediment loads. Use a settling tank or sand filter as pretreatment when possible.

F. It may be necessary to use a combination of dewatering practices to achieve the intended results.

VII. Plans and Specifications

All plans, standard detail drawings, or specifications shall include the schedule for installation, inspection, and maintenance and shall be kept on-site with the erosion control plan.

VIII. Operation and Maintenance

A. Sediment shall be removed from devices to maintain effectiveness. All sediment collected in dewatering devices shall be properly disposed of to prevent discharge to waters of the state.

B. The following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site:

1. Discharge duration and specified pumping rate
2. Observed water table at time of dewatering.
3. If used, type and amount of chemical used for pH adjustment
4. If used, type and amount of polymer used for treatment
5. Maintenance activities

IX. References

The American Association of State Highway Officials (AASHTO) Soil Classification System

X. Definitions

Exceptional Resource Waters (ERW) (V.B.1): are waters listed in s. NR 102.11.

Highly susceptible wetland (VI.B): include the following types: fens, sedge meadows, bogs, low prairies, conifer swamps, shrub swamps, other forested wetlands, fresh wet meadows, shallow marshes, deep marshes and seasonally flooded basins.

Karst feature (III): are an area or geologic feature subject to bedrock dissolution so that it is likely to provide a conduit to groundwater, and may include caves, enlarged fractures, mine features, exposed bedrock surfaces, sinkholes, springs, seeps or swallets.

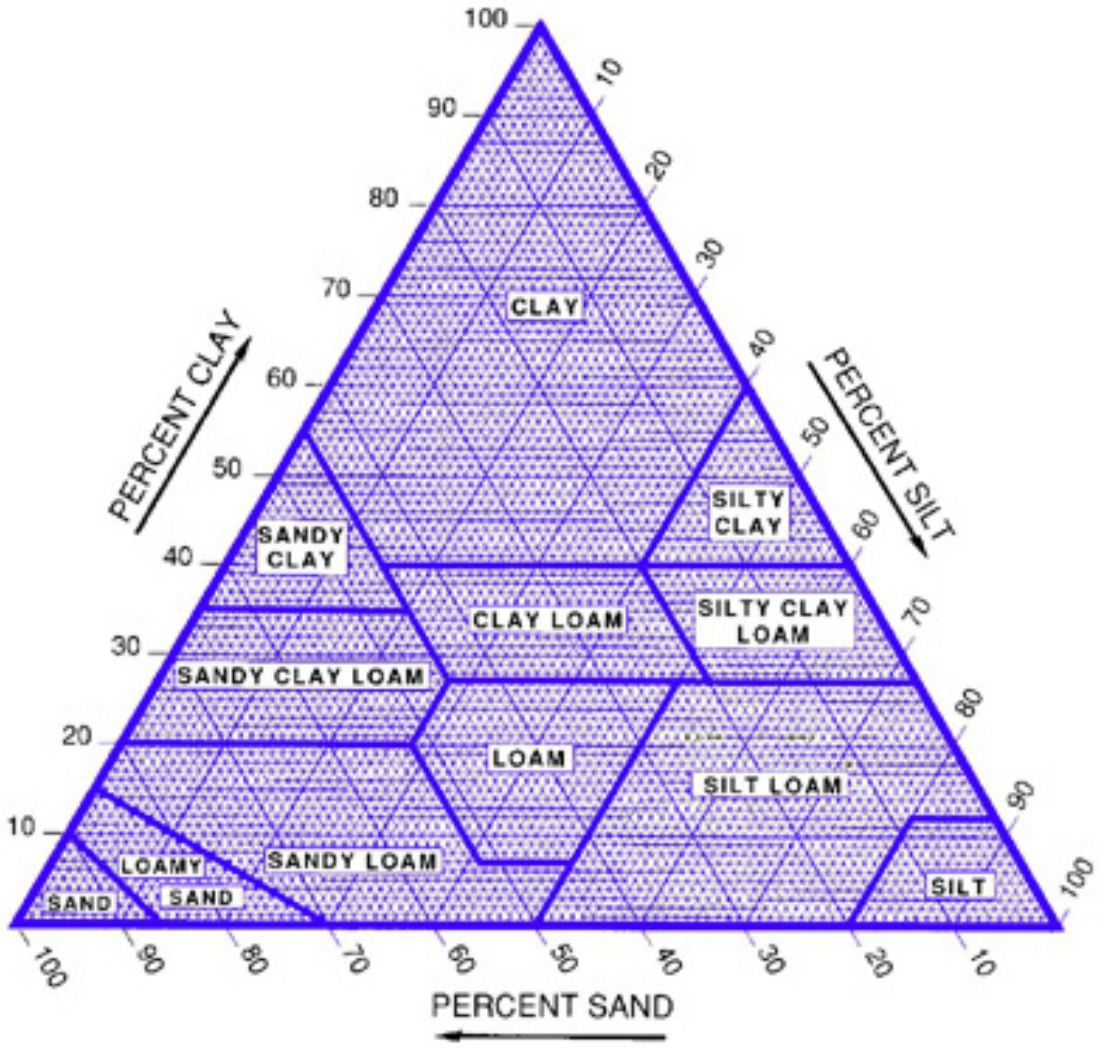
Less susceptible wetland (VI.B)*:* include degraded wetlands dominated by invasive species such as reed canary grass.

Outstanding Resource Waters (ORW) (V.B.1): are waters listed in s. NR 102.10

Targeted performance standard (IV): means a performance standard that will apply in a specific area, where additional practices beyond those contained in NR 151 are necessary to meet water quality standards.

Treatment facility (V.B.3): includes wastewater treatment plants or wet detention basins constructed in accordance with WDNR Conservation Practice Standard 1001 Wet Detention Basin or other approved land application sites.

Figure 1: USDA Soil Textural Triangle



[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Figure 2: Dewatering Practice Selection Matrix

Type of Dewatering Practice	Soil and Particle Size Classification			Notes
	Coarse to Medium Particles	Medium to Fine Particles	Fine to Very Fine Particles	
	Sand, Loamy Sands, and Sandy Loams	*Loams, Silt Loams, and Silts*	*Clay Loams, Silty Clays and Clay*	
Geotextile Bags				
Type I	▬	●		
Type II	■	▬	●	
Gravity Based Settling				
Sediment Tank (Portable)	▬	●		
Sediment Trap (Temporary)	▬	●		Use Standard 1063 Sediment Trap
Sediment Basin (Temporary)	▬	▬	●	Use Standard 1064 Sediment Basin
Wet Detention Basin (Perm)	▬	▬	▬	Use Standard 1001 Wet Detention Basin
Passive Filtration				
Filter Tank (Portable)	▬	▬	●	Use according to manufacturer's recommendations
Filter Basin	▬	▬	●	See WisDOT Standard Specifications
Vegetative Filter	▬	▬	▬	Effectiveness depends upon the width of the filter and the runoff rate of flow. See Standard 1054 for design guidelines.
Pressurized Filtration				The contractor shall provide a certification sheet from the manufacturer specifiying performance of the device based on soil type and pumping rate.
Portable Sand Filter	▬	●	●	
Wound Cartridge Units	■	▬	▬	
Membranes & Micro-filtration	■	■	■	Very effective but high maintenance requirements
Other Practices				
Sanitary Sewer Discharge	▬	▬	▬	
Pump Truck	▬	▬	▬	Transported to treatment facility
Alternative Method				Discuss with regulatory authority

Key:

Effective range of device: ▬

Device applicable but may not be cost effective: ■

Effective range with addition of polymer: ●

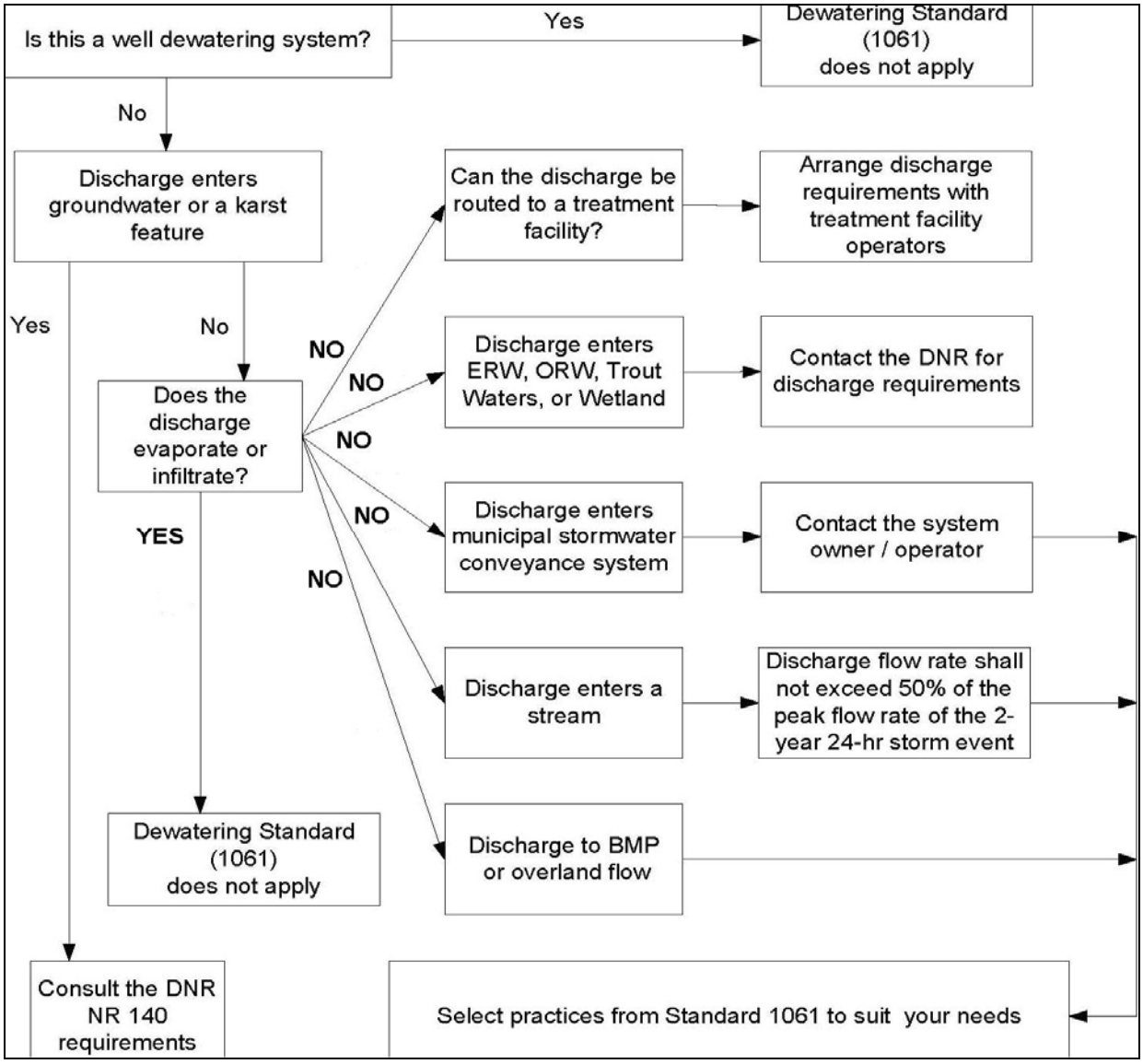
Notes:

(1) The effectiveness of many practices can be enhanced through the use of polymer mixture.

(2) Soil classification shall be done in accordance to an accepted method (i.e. USDA, AASHTO)

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Figure 3: Factors Influencing The Selection of Dewatering Practices



If the dewatering effluent is discolored, has an order, an oily sheen, or other toxins are present notify the DNR immediately

24 Hours Spills Reporting Hotline 1-800-943-0003

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Ditch Check
(Channel)
(1062)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A temporary dam constructed across a swale or drainage ditch to reduce the velocity of water flowing in the channel. *Ditch checks*[1] can be constructed out of stone, a double row of straw bales or from engineered products found on the Wisconsin Department of Transportation (WisDOT) Erosion Control Product Acceptability List (PAL).

II. Purpose

The purpose of this practice is to reduce flow velocity and to pond water, thereby reducing active channel erosion and promoting settling of suspended solids behind the ditch check.

III. Conditions Where Practice Applies

This Standard applies where grading activity occurs in areas of channelized flows and a temporary measure is needed to control erosion of the channel until permanent stabilization practices can be applied.

Under no circumstance shall ditch checks be placed in intermittent or perennial stream without permission from WDNR. This Practice may not be substituted for major perimeter trapping measures.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of ditch checks. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements.

A. Height

1. Installed, the minimum height of ditch checks shall be 10 inches and shall not exceed a maximum height of 16 inches for manufactured or biodegradable materials and 36 inches for stone (or other inorganic materials).

2. Ditch checks must be installed with the center lower than the sides forming a weir. If this is not done stormwater flows are forced to the edge of the ditch check thus promoting scour, or out of the channel causing excessive erosion

3. Stone ditch checks shall have a minimum top width of 2-feet measured in the direction of flow with maximum slopes of 2:1 (2 horizontal to 1 vertical) on the upslope side and 2:1 on the down slope side.

B. Placement

1. At a minimum install one ditch check for every two feet of drop in the channel.

2. Ditch checks shall be placed such that the resultant ponding will not cause inconvenience or damage to adjacent areas.

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

C. Material Specifications

1. Stone ditch checks shall be constructed of a well-graded angular stone, a D_{50} of 3 inch or greater, sometimes referred to as breaker run or shot rock.

2. Ditch checks may be constructed of other approved materials but must be capable of withstanding the flow velocities in the channel. Manufactured products listed in WisDOT's PAL are also acceptable for temporary ditch checks.

   Note: Silt fence and single rows of straw bales are ineffective as ditch checks and are not permitted.

D. Construction - Refer to Figure 1 & 2

1. Ditch checks shall be utilized during rough grading and shall be removed once the final grading and channel stabilization is applied, unless intended to be part of a permanent stormwater management plan.

2. Channel erosion mat or other non-erodible materials shall be placed at the base of a ditch check, and extended a minimum of 6 feet, to prevent scour and washing out the toe of the ditch check. DNR Conservation Practice Channel Erosion Mat (1053) contains criteria for the placement of erosion mat in this location.

3. Chink or seal stone and rock ditch checks to minimize the flow through the ditch check.

VI. Considerations

A. For added stability, the base of a stone or rock ditch check should be keyed into the soil to a depth of 6-inches.

B. Stone ditch checks may be underlain by a nonwoven geotextile fabric to ease installation and removal. If the geotextile fabric is extended, it can serve purpose specified in section V.D.2

C. Ditch checks installed in grass lined channels may kill the vegetation if water is ponded for extended periods or excessive siltation occurs. Proper maintenance is required to keep areas above and below the ditch check stabilized.

D. The best way to prevent sediment from entering the storm sewer system is to stabilize the disturbed area of the site as quickly as possible, preventing erosion and stopping sediment transport at its source.

E. When placing ditch checks in swales adjacent to roadways consider designating a 'clear zone' free of obstacles posing a threat to out of control vehicles.

F. Mowing operations may throw stones from ditch checks causing a potential safety hazard.

VII. Plans and Specifications

A. Plans and specifications for installing ditch checks shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall address the following:

   1. Location and spacing of ditch check

   2. Schedules and sequence of installation and removal

   3. Standard drawings and installation details

   4. Rock gradation

B. All plans, standard detail drawings, or specifications shall include schedule for installation, inspection, and maintenance. The responsible party shall be identified.

VIII. Operation and Maintenance

A. Ditch checks shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24 hour period.

B. Unless incorporated into a permanent stormwater management system, ditch

checks shall be removed once the final grading and channel stabilization is applied.

C. Sediment deposits shall be removed when deposits reach 0.5 the height of the barrier. Removal of sediment may require replacement of stone. Maintenance shall be completed as soon as possible with consideration to site conditions.

IX. References

WisDOT "Erosion Control Product Acceptability List" is available online at: http://www.dot.wisconsin.gov/business/engrserv/pal.htm Printed copies are no longer distributed.

X. Definitions

D_{50} (V.C.1): The particle size for which 50% of the material by weight is smaller than that size.

Ditch Checks (I) Are commonly referred to as temporary check dams. Stone ditch checks refer to those made out of either stone or rock.

Sediment Trap
(1063)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A *temporary*[1] sediment control device formed by excavation and/or embankment to intercept sediment-laden runoff and to retain the sediment.

II. Purposes

To detain sediment-laden runoff from disturbed areas for sufficient time to allow the majority of the sediment to settle out.

III. Conditions Where Practice Applies

Sediment traps are utilized in areas of concentrated flow or points of discharge during construction activities. Sediment traps shall be constructed at locations accessible for clean out. Sediment traps are designed to be in place until the contributory drainage area has been *stabilized*.

The contributory drainage area shall be a maximum of five acres. For concentrated flow areas smaller than one acre, ditch checks may be installed; refer to WDNR conservation practice standard Ditch Check (1062).

For larger drainage areas and/or for sediment basins requiring an engineered outlet structure refer to WDNR conservation practice standard Sediment Basin (1064) or Wet Detention Basin (1001).

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of sediment traps. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements.

A. **Timing** – Sediment traps shall be constructed prior to disturbance of up-slope areas and placed so they function during all phases of construction. Sediment traps shall be placed in locations where runoff from disturbed areas can be diverted into the traps.

B. **Sizing Criteria** – Properly sized sediment traps are relatively effective at trapping medium and coarse-grained particles. To effectively trap fine-grained particles, the sediment trap must employ a large surface area or polymers.

The specific trapping efficiency of a sediment trap varies based on the surface area, depth of dead storage, and the particle size distribution and concentration of sediment entering the device.

1. Surface Area – The minimum surface area of a sediment trap shall be based on the dominant textural class of the soil entering the device. The surface area calculated below represents the surface for the permanent pool area (if wet) or the surface area for the dead storage. This surface area is measured at the invert of the stone outlet (see Figure 1).

   a. For coarse textured soils (loamy sand, sandy loam, and sand):

$$A_{s\ (coarse)} = 625 * A_{dr}$$

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

b. For medium textured soils (loams, silt loams, and silt):

$$A_{s\ (medium)} = 1560 * A_{dr}$$

c. For fine textured soils (sandy clay, silty clay, silty clay loam, clay loam, and clay):

$$A_{s\ (fine)} = 5300 * A_{dr}$$

For the equations above:

A_s = surface area of storage volume in square feet
A_{dr} = contributory drainage area in acres

Note: The equations above were derived using a representative particle distribution for detached sediment for each textural class. Sediment traps designed based on this standard will achieve 80% reduction of suspended solids for the drainage area.

d. The surface area of sediment traps used in areas with fine to medium sized soils can be reduced when used in conjunction with water applied polymers. When employing polymers, size the surface area for controlling fine particles using the criteria for medium soils (V.B.1.b.) and when controlling medium sized particles use the sizing equation contained in (V.B.1.a.) for coarse soils. See WDNR Conservation Practice Standard Sediment Control Water Application of Polymers (1051) for criteria governing the proper use and selection of polymers.

2. Depth – The depth of the sediment trap measured from the sediment trap bottom to the invert of the stone outlet, shall be at least three feet to minimize re-suspension and provide storage for sediment.

3. Shape – The sediment trap shall have a length to width ratio of at least 2:1. The position of the outlet to the inlet shall be as such to minimize short-circuiting of the water flow path.

4. Side Slopes – Side slopes shall be no steeper than 2:1.

Note: A sediment trap sized with the surface area equations above, a three-foot depth, and 2:1 side slopes will generally result in an 80% sediment reduction. Slopes flatter than 2:1 will require larger surface areas to provide adequate storage.

C. **Embankment –** Embankments of temporary sediment traps shall not exceed five feet in height measured from the downstream toe of the embankment to the top of the embankment. Construct embankments with a minimum top width of four feet, and side slopes of 2:1 or flatter. Earthen embankments shall be compacted.

Where sediment traps are employed as a perimeter control, the embankments shall have stabilization practices place prior to receiving runoff.

D. **Outlet –** Sediment traps shall be constructed with both a principal and emergency spillway. The stone outlet of a sediment trap shall consist of a stone section of embankment (stone outlet) located at the discharge point. The stone outlet section provides a means of dewatering the basin back to the top of the permanent storage between storm events, and also serves as a non-erosive emergency spillway for larger flow events.

1. Outlet Size – The size of the outlet shall depend on the contributory drainage area and desired outflow. The length of the stone outlet / weir outlet can be calculated based on the size of the drainage area found in Table 1. Refer to section IX References for the equation used to calculate flow through a stone outlet or gabion.

Table 1 Weir Length

Drainage Area (acres)	Weir Length (feet)
1	4.0
2	6.0
3	8.0
4	10.0
5	12.0

The emergency spillway (top of the weir) shall be sized to adequately pass the 10-year 24-hour storm without over topping the sediment trap. The crest of the spillway shall be at least one foot below the top of the embankment. The minimum weir lengths provided in Table 1 are adequate to pass the 10 year event.

Note: The weir length has little effect on overall treatment efficiency provided the sizing criteria in Section V.B. is adhered too.

The stone outlet shall have a minimum top width of 2 feet and a maximum side-slope of 2:1.

Discharge from the sediment basin shall be safely conveyed to a stormwater facility, drainage way, or waterbody. The discharge velocity shall be below the velocity to initiate scour unless appropriate stabilization methods are employed.

2. Stone Size – Stone shall consist of angular well graded 3 to 6 inch clear washed stone.

3. Keyway Trench – The stone outlet shall be protected from undercutting by excavating a keyway trench across the stone foundation and up the sides to the height of the outlet. See Figure 1. Underlying with geotextile fabric is optional.

E. Provide access for cleanout and disposal of trapped sediment.

VI Considerations

A. Sediment traps generally require excessive surface areas to settle clay particles and fine silts. If these conditions exist on the site consider using a sediment basin (DNR Conservation Practice Standard Sediment Basin 1064) or adding polymer to the sediment trap. See WDNR Conservation Practice Standard Sediment Control Water Application of Polymers (1051) for criteria governing the use of polymers

B. To improve trapping efficiency, filter fabric can be placed on the up-slope side of the stone outlet / gabion and anchored with stone. When fabric is utilized to enhance filtering, more frequent maintenance is required to prevent clogging. When using fabric, a monofilament type fabric shall be used (such as WisDOT Type FF). The apparent opening size of the fabric, not the stone size, will dictate the flow rate through the outlet therefore outlet lengths need to be calculated since values in Table 1 are based on stone. When calculating the size of the outlet a clogging factor of 50% should be used for the fabric.

C. Consider possible interference with construction activities when locating sediment traps.

D. Provisions should be made for protecting the embankment from failure caused by storms exceeding the 10-year design requirement. Consider a stabilized and non-erosive emergency spillway bypass.

E. In general, groundwater impacts from temporary sediment traps that have storage areas in contact with groundwater are not a major concern. However, sediment trap contact with groundwater should be avoided in areas with karst features, fractured bedrock, or areas of significant groundwater recharge.

F. Sediment trapping is achieved primarily by settling within the pool formed by the trap. Sediment trapping efficiency is a function of surface area, depth of pool, and detention time. If site conditions permit, a length to width ratio greater than 2:1 will increase efficiency.

G. If site conditions prevent the sediment trap from having a three-foot depth, then an equivalent storage volume must be created through increasing the surface area.

H. For sediment traps in place longer than 6 months, consider outlets constructed of two types of stone. A combination of coarse aggregate and riprap (WisDOT light riprap classification) should be used to provide stability. A one-foot layer of one inch washed stone then should be placed on the up-slope face to reduce drainage flow rate.

VII Plans and Specifications

A. Plans and specifications for installing sediment traps shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The plans and specifications shall address the following:

   1. Location and spacing of sediment traps

   2. Schedules and sequence of installation and removal

   3. Standard drawings and installation details

   4. Rock gradation

B. All plans, standard detail drawings, or specifications shall include a schedule for installation, inspection, maintenance, and identify the responsible party.

VIII Operation and Maintenance

Sediment Traps shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period. Sediment may need to be removed more frequently.

A. Deposits of sediment shall be removed when they reach a depth of one foot.

B. If the outlet becomes clogged it shall be cleaned to restore flow capacity.

C. Recommend provisions for proper disposal of the sediment removed from the trap.

D. Maintenance shall be completed as soon as possible with consideration given to site conditions.

E. Sediment traps shall be removed and the location stabilized after the disturbed area draining to the sediment trap is stabilized and no longer susceptible to erosion.

IX References

Flow through the stone outlet and gabion can be calculated using the following equation:

$$Q = (h^{2/3} * L) / [(W/D) + 25 + W^{2}]^{1/2}$$

Where:
- Q = total flow through stone (cfs)
- h = depth of flow measured from invert of the stone outlet to the crest of emergency spillway (ft)
- W = average width of weir or flow length through stone outlet (ft)
- L = length of weir (ft)
- D = Average Rock Diameter (ft)

Note: For a stone outlet, the length of stone outlet (L) will vary with the depth and slope of stone outlet. For a gabion, the length of flow is fixed to gabion width.

A complete discussion of this equation and its proper application can be found in:

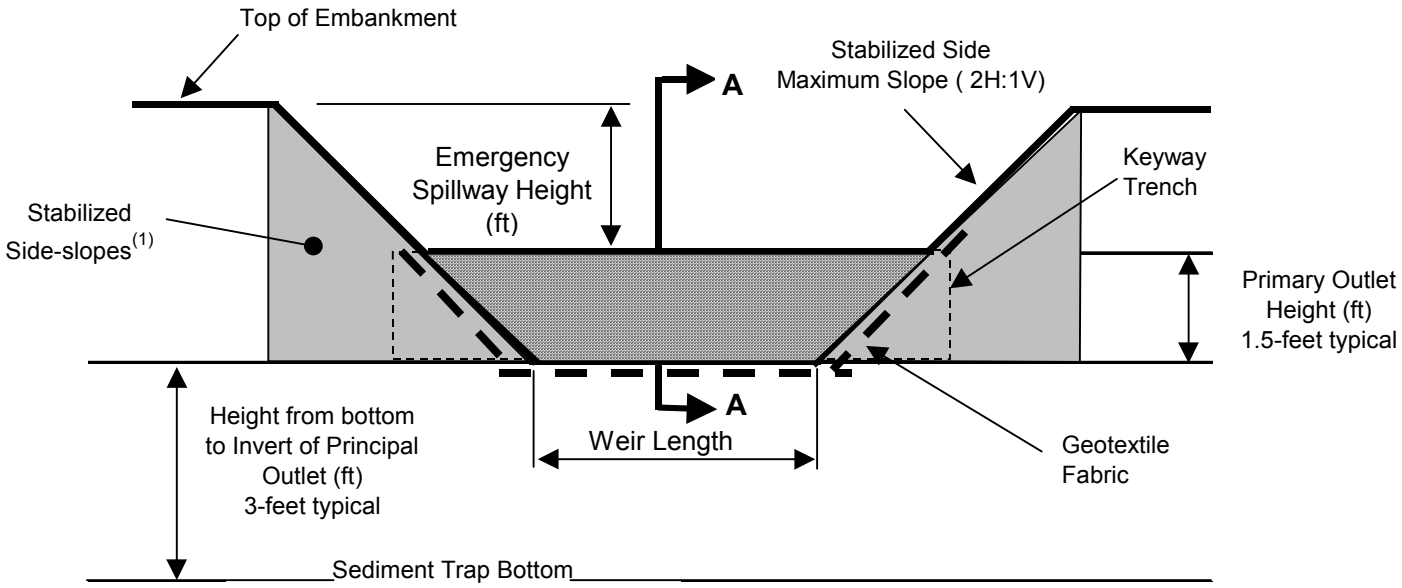
C. McIntyre, G. Aron, J. Willenbrock, and M. Deimler. Report No. 10: Analysis of flow through porous media as applied to gabion dams regarding the storage and release of storm water runoff. NAHB/NRC Designated Housing Research Center at Penn State, Department of Civil Engineering; August 1992.

X Definitions

Stabilized (III): Means that all land disturbing construction activities at the construction site have been completed and that a uniform perennial vegetative cover has been established with a density of at least 70% of the cover for the unpaved areas and areas not covered by permanent structures or that employ equivalent stabilization measures.

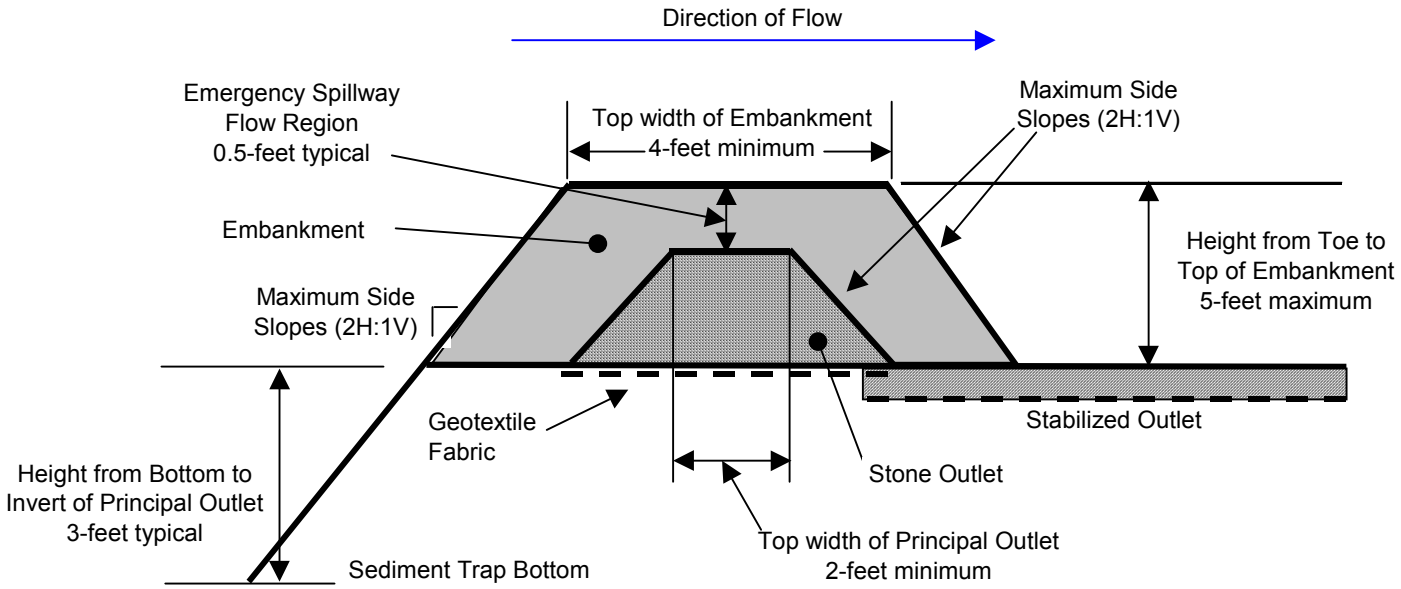
Temporary (I): An erosion control measure that is in place for the duration of construction or until the site is stabilized.

Figure 1: Sediment Trap Outlet Detail



Cross-section View of Principal Outlet

Notes: (1) Side-slopes and faces of earthen embankment around outlet shall be armored with riprap or stabilized with erosion mat sufficient to handle flows from the 10-year storm.



View A - A of Principal Outlet

Sediment Basin
(1064)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

A sediment control device constructed with an engineered outlet, formed by excavation or embankment to intercept sediment-laden runoff and retain the sediment.

II. Purposes

Detain sediment-laden runoff from disturbed areas for sufficient time to allow the majority of the sediment to settle out.

III. Conditions Where Practice Applies

Sediment basins are utilized in areas of concentrated flow or points of discharge during construction activities. Sediment basins shall be constructed at locations accessible for clean out. Site conditions must allow for runoff to be directed into the basin.

Sediment basins are designed to be in place until the contributory drainage area has been *stabilized*[1]. Sediment basins are temporary and serve drainage areas up to 100 acres however other conservation practices are often more economical for smaller drainage areas. For drainage areas smaller than 5 acres sediment traps or ditch checks may be applicable; for design criteria refer to WDNR conservation Practice Standard Sediment Trap (1063) or Ditch Check (1062).

Design to WDNR Conservation Practice Standard Wet Detention Basin (1001) when a permanent stormwater basin is required.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing the use and placement of sediment basins. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements. Sediment basins meeting these design criteria are deemed 80% effective by design in trapping sediment.

A. **Timing** – Sediment basins shall be constructed prior to disturbance of up-slope areas and placed so they function during all phases of construction. Sediment basins shall be placed in locations where runoff from disturbed areas can be diverted into the basin.

B. **Sizing Criteria** – Properly sized sediment basins are more effective at trapping fine-grained particles than sediment traps. Specific trapping efficiency varies based on the surface area and the particle size distribution of the sediment entering the device. See Figure 1 for clarification of terms. Attachment 1 includes a sample design problem.

1. *Treatment Surface Area* – The surface area of the sediment basin measured at the invert of the lowest outlet. The treatment surface area shall be sized based on the texture of the soil entering the device and the peak outflow during the 1-year, 24-hour design storm using Equation 1:

$$S_a = 1.2 * (q_{out} / v_s)$$

Where:

S_a = Treatment surface area measured at the invert of the lowest outlet of sediment basin (square feet)

q_{out} = Peak outflow (cubic feet / second) during the 1-year, 24-hour design storm for the principal outlet

v_s = Particle settling velocity (feet/second)

1.2 = EPA recommended safety factor.

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Particle settling velocities (*V*s) shall be based on representative soil class as follows:

a. Soil Class 1: $v_s = 1.2*10^{-3}$ ft/sec
b. Soil Class 2: $v_s = 7.3*10^{-5}$ ft/sec
c. Soil Class 3: $v_s = 1.2*10^{-5}$ ft/sec

Note: Particle settling velocities calculated assuming a specific gravity of 2.65 and a water temperature of 68 degrees Fahrenheit.

Soil Class 1 includes particles greater than 20 microns generally corresponding to sand, loamy sand, and sandy loam.

Soil Class 2 includes particles between 5 and 20 microns generally corresponding to loam, silt, and silt loam aggregates as transported in runoff.

Soil Class 3 includes particles between 2 and 5 microns generally corresponding to clay loam, silty clay, and clay aggregates as transported in runoff.

The representative soil class shall be selected based on the dominant textural class of the soil entering the device.

The treatment surface area of sediment basins can be reduced when used in conjunction with water applied polymers. When employing polymers, size the treatment surface area for controlling fine soils (Class 3) using the settling velocity for medium soils (Class 2). When designing for medium sized soils (Class 2) use the settling velocity for coarse soils (Class 1). See WDNR Conservation Practice Standard Sediment Control Water Application of Polymers (1051) for criteria governing the proper use and selection of polymers.

2. Depth below Treatment Surface Area – The depth below the treatment surface area as measured from the invert of the lowest outlet of the sediment basin shall be a minimum of 5 feet deep (2 feet for sediment storage plus 3 feet to protect against scour/ resuspension) and a maximum of 10 feet deep to limit the potential for thermal stratification.

   Due to side slope requirements and safety shelf considerations it maybe difficult to maintain 5 feet of depth for the entire treatment surface area. Therefore, 50% of the total treatment surface area shall be a minimum of 5 feet deep. For basins less than 5,000 square feet, maximize the area of 5 feet depth.

   Interior side slopes below the lowest invert shall be 2:1 (horizontal: vertical) or flatter to maintain soil stability.

   While a permanent pool of water below the lowest invert may form, it is not required to be maintained through irrigation or installation of a liner system.

3. *Active Storage Volume* – The volume above the treatment surface area shall be calculated using one of the following methods:

   a. The method outlined in TR-55 for determining the storage volume for detention basins. This can be accomplished by using Figure 2 where:

      q_o = Peak outflow (cubic feet / second) during the 1-year, 24-hour design storm for the principal outlet calculated using Equation 1 (see section V.B.1).

      q_i = Calculated peak inflow or runoff rate (cubic feet / second) during the 1-year, 24-hour design storm.

      Vr = Calculated volume of runoff from the 1-year 24-hour design storm for the entire contributory area with the maximum area of disturbance characterized as bare soil.

      Vs = Is the required active storage volume determined using Figure 2.

b. The active storage volume may be calculated based on routing the 1-year, 24-hour storm provided the principal outlet requirements stipulated in section V.D.2 are maintained. This method will require the use of a model.

Note: Both these methods require iterative calculations.

4. Shape – The length to width ratio of the flow path shall be maximized with a goal of 3:1 or greater. The flow path is considered the general direction of water flow within the basin including the treatment surface area and any forebay.

C. **Embankments** – Earthen embankments shall be designed to address potential risk and structural integrity issues such as seepage and saturation. All constructed earthen embankments shall meet the following criteria.

1. The base of the embankment shall be stripped of all vegetation, stumps, topsoil and other organic matter.

2. Side slopes shall be 3:1 or flatter. The minimum embankment top width shall be adequate to provide structural stability. Where applicable the top width shall be wide enough to provide maintenance access.

3. There shall be a core trench or key-way along the embankment.

4. Any pipes extending through the embankment shall be bedded and backfilled with equivalent soils used to construct the embankment. The bedding and backfill shall be compacted in lifts and to the same standard as the original embankment. Excavation through a completed embankment shall have a minimum side slope of 1:1 or flatter.

5. Measures shall be taken to minimize seepage along any conduit buried in the embankment.

D. **Outlet** – Sediment basins shall have both a principal outlet and an overflow spillway.

1. Timing – Outlets must be constructed in conjunction with the remainder of the basin and must be constructed prior to the basin receiving runoff. Sediment basins are ineffective until the outlet is constructed.

2. Principal Water Quality Outlet – The principal water quality outlet shall be designed to pass the 1-year 24-hour storm without use of the overflow spillway or other outlet structures. The maximum outflow (q_o) from the principal water quality outlet shall be less than or equal to the q_o used in Equation 1 (V.B.1). If the sediment basin is to serve as a permanent stormwater basin, the principal outlet structure can be modified (i.e. removable plates) to meet flow requirements encountered during and after construction; separate outlet structures do not need to be constructed.

Note: Local ordinances may require control of larger storm events such as the 2-year 24 hour storms. In these cases, additional or compound outlets maybe required.

3. Overflow (Emergency) Spillway – An overflow spillway shall be provided consisting of an open channel constructed adjacent to the embankment and built over a stabilized area. The spillway shall be designed to carry the peak rate of runoff expected from a 10-year, 24-hour design storm or one commensurate with the degree of hazard, less any reduction due to flow in the principal outlet. The top of the embankment shall be at least one foot above the design high water level and a minimum of 1 foot above the invert of the overflow spillway. The overflow spillway shall be protected from erosion. Flow from the overflow spillway shall be directed away from the embankment.

4. Outlet Protection – All outlet designs shall incorporate preventive measures for ice damage, trash accumulation, and erosion at the outfall. For orifices less

than 8-inches in diameter, or equivalent, additional measures to prevent clogging are required.

E. **Inlet Protection** – Inlets shall be designed to prevent scour and reduce velocities during peak flows. Possible design options include flow diffusion, plunge pools, directional berms, baffles, or other energy dissipation structures.

F. **Location** – Temporary sediment basins should be located to provide access for cleanout and disposal of trapped sediment.

G. **Removal** – Temporary sediment basins shall be removed after the contributing drainage area has been stabilized. Complete final grading and restoration according to the site plans. If standing water needs to be removed it shall be done in accordance with WDNR Conservation Practice Standard Dewatering (1061).

VI. Considerations

A. When constructing a sediment basin that will also serve as the long-term stormwater detention pond, build the sediment basin to the larger of the two sizes required either for stormwater control or erosion control. In addition, when sizing the outlet structure first design the outlet for the long-term stormwater management requirements then check to satisfy the flow requirements for sediment control during construction. If additional flow restriction is needed consider use of a temporary restriction plates or other measures to avoid having to construct separate outlet structures for the sediment basin and stormwater basin.

B. Over-excavation beyond the required depth in the sediment storage area of the sediment basin may allow for less frequent maintenance. Addition of other measures in the contributing drainage area may reduce sediment accumulation and associated maintenance requirements.

C. The use of a sediment forebay can extend the useful life of the main sediment storage area by trapping the majority of sediment in the forebay area. Separation of the forebay from the rest of the basin requires construction of a submerged shelf (if wet) or a stone or stabilized earthen embankment. The forebay should have a surface area equal to at least 12% of the total basin area.

D. In addition to soil stability issues, interior slopes of sediment basins should be selected based on safety issues commensurate with the degree of hazard.

VII. Plans and Specifications

A. Plans and specifications for installing sediment basins shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

1. Location of sediment basin
2. Schedules and sequence of installation and removal
3. Standard drawings and installation details
4. Control structure detail and layout
5. Sizing of sediment storage area
6. Maintenance requirements

B. All plans, standard detail drawings, or specifications shall include sequence for installation, inspection, and maintenance requirements. The responsible party shall be identified.

VIII. Operation and Maintenance

Sediment basins shall, at a minimum, be inspected weekly and within 24 hours after every precipitation event that produces 0.5 inches of rain or more during a 24-hour period.

A. Sediment shall be removed to maintain the three foot depth of the treatment surface area as measured from the invert of the principal outlet. Sediment may need to be removed more frequently.

B. If the outlet becomes clogged it shall be cleaned to restore flow capacity.

C. Provisions for proper disposal of the sediment removed shall be made.

D. Maintenance shall be completed as soon as possible with consideration to site conditions.

IX. References

Chapter NR 333, Dam and Design Construction.

Hann, Barfield, and Hayes. Design Hydrology and Sedimentology for Small Catchments. Academic Press Inc., 1994.

Robert E. Pitt, Small Storm Hydrology.

US Bureau of Reclamation, Design of Small Dams. http://www.usbr.gov/pmts/hydraulics_lab/pubs/index.cfm.

USDA, Natural Resources Conservation Service, Ponds – Planning, Design, Construction. Agriculture Handbook No. 590, Revised September 1997.

WDNR Conservation Practice Standard 1001 Wet Detention Basin.

X. Definitions

Active Storage Volume (V.B.3) – Is measured from the invert of the lowest outlet to the invert of the emergency spillway.

Stabilized (III) – Means protecting exposed soil from erosion.

Treatment Surface Area (V.B.1) – Is the surface area of the sediment basin measured at the invert of the lowest outlet.

Figure 1:

Clarification of Sediment Basin Terminology

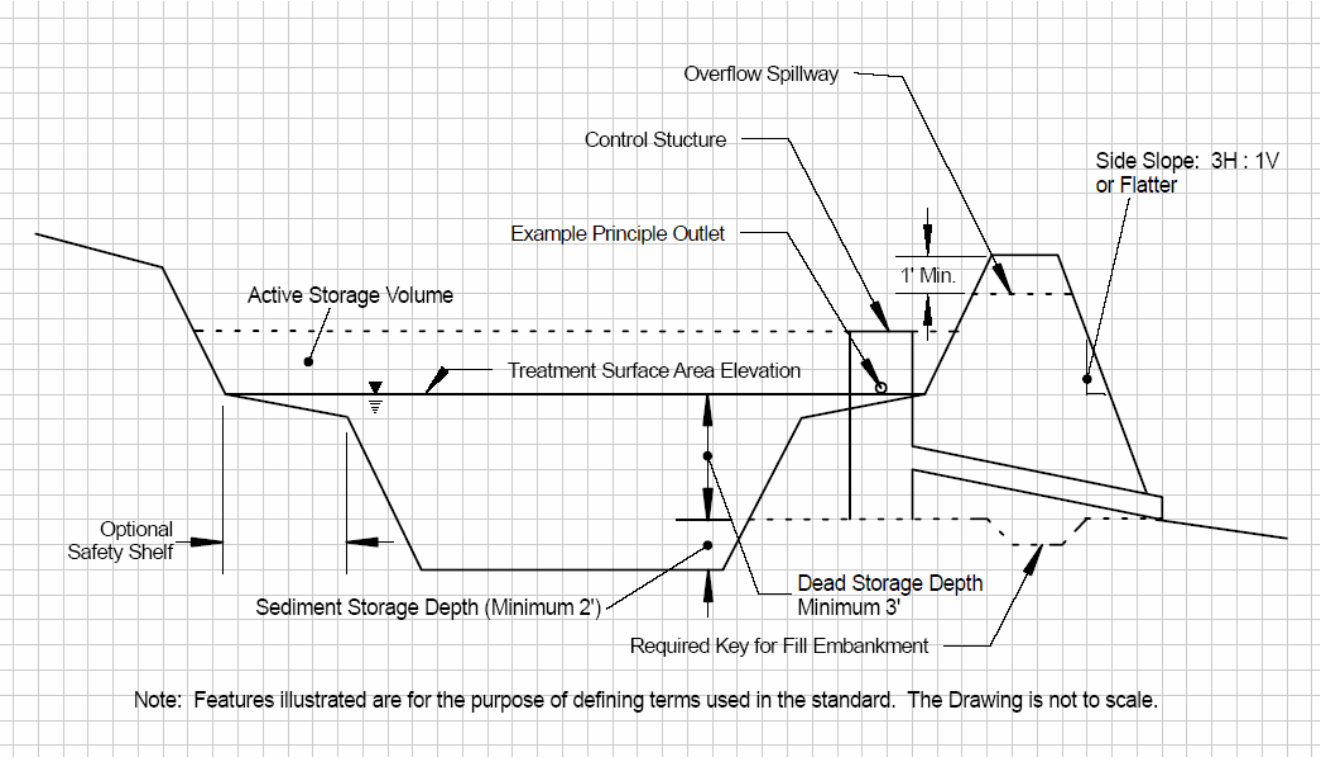
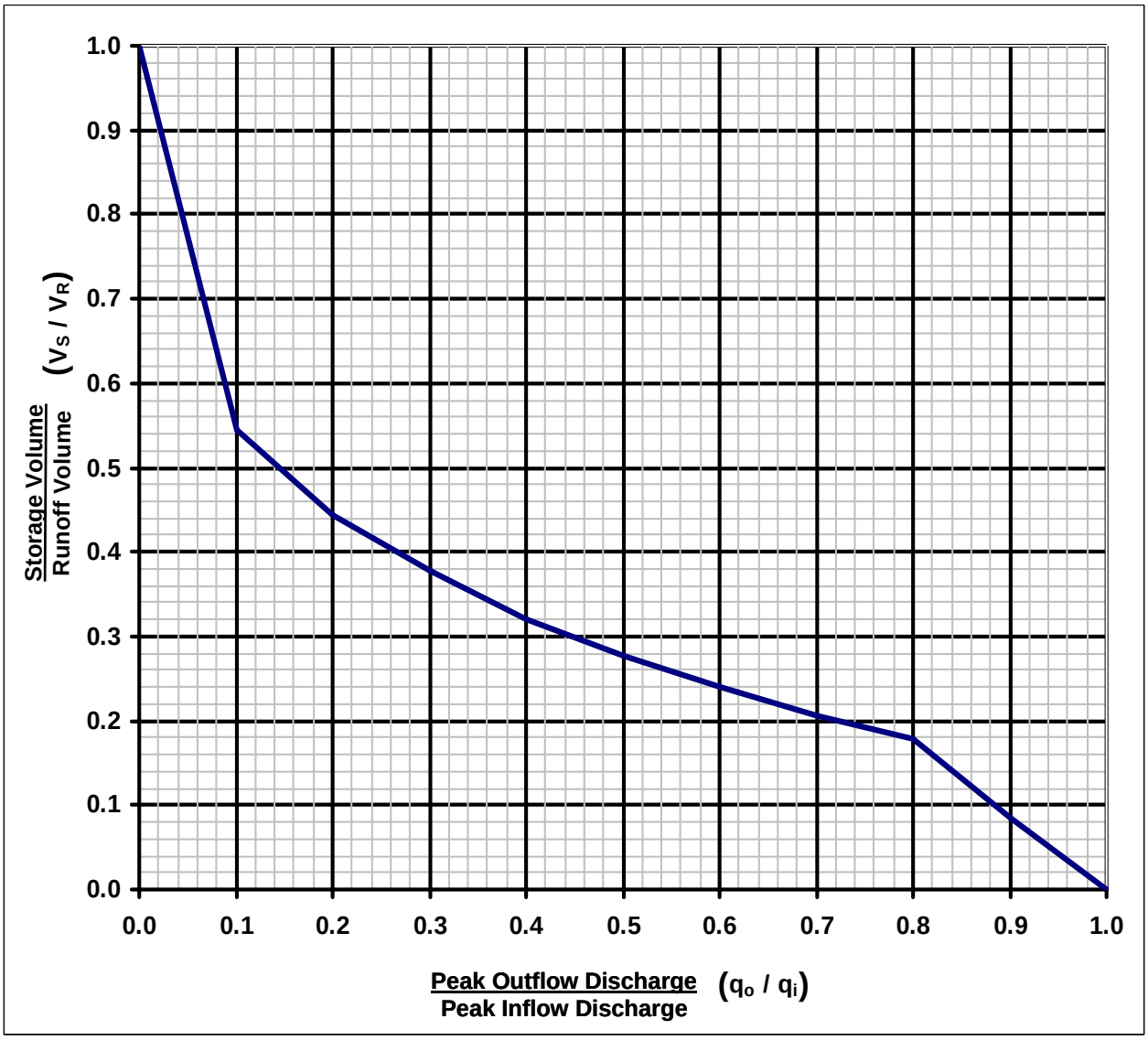


Figure 2:

Approximate Detention Basin Routing for Type II Storms



Source: Technical Release 55, United States Department of Agriculture, Natural Resources Conservation Service. Washington D.C. 1988.

Rainfall Quantities:

Table 1 provides a summary of the 1-year, 24-hour rainfall totals using NRCS mandated TP-40 which has not been updated since 1961. Table 2 provides a summary of more current data from the Rainfall Frequency Atlas of the Midwest published in 1992. Local requirements may dictate the use of one dataset over the other.

Table 1 - Rainfall for Wisconsin Counties for a 1 - year, 24 - hour Rainfall[1]	
Inches of Rainfall	County
2.1 in.	Door, Florence, Forest, Kewaunee, Marinette, Oconto, Vilas
2.2 in.	Ashland, Bayfield, Brown, Calumet, Douglas, Iron, Langlade, Lincoln, Manitowoc, Menominee, Oneida, Outagamie, Price, Shawano, Sheboygan
2.3 in.	Barron, Burnett, Dodge, Fond du Lac, Green Lake, Marathon, Milwaukee, Ozaukee, Portage, Racine, Rusk, Sawyer, Taylor, Washburn, Washington, Waukesha, Waupaca, Waushara, Winnebago, Wood
2.4 in.	Adams, Chippewa, Clark, Columbia, Dane, Dunn, Eau Claire, Jackson, Jefferson, Juneau, Kenosha, Marquette, Pepin, Pierce, Polk, Rock, St. Croix, Walworth
2.5 in.	Buffalo, Green, Iowa, La Crosse, Monroe, Richland, Sauk, Trempealeau, Vernon
2.6 in.	Crawford, Grant, Lafayette
[1]TP - 40 - Rainfall Frequency Atlas of the United States, U.S. Department of Commerce Weather Bureau.	

Table 2 - Rainfall for Wisconsin Counties for a 1 - year, 24 - hour Rainfall[2]		
Zone	Inches of Rainfall	County
1	2.22	Douglas, Bayfield, Burnett, Washburn, Sawyer, Polk, Barron, Rusk, Chippewa, Eau Claire
2	2.21	Ashland, Iron, Vilas, Price, Oneida, Taylor, Lincoln, Clark, Marathon
3	1.90	Florence, Forest, Marinette, Langlade, Menominee, Oconto, Door, Shawano
4	2.23	St. Croix, Dunn, Pierce, Pepin, Buffalo, Trempealeau, Jackson, La Crosse, Monroe
5	2.15	Wood, Portage, Waupaca, Juneau, Adams, Waushara, Marquette, Green Lake
6	1.96	Outagamie, Brown, Kewaunee, Winnebago, Calumet, Manitowac, Fond Du Lac, Sheboygan
7	2.25	Vernon, Crawford, Richland, Sauk, Grant, Iowa, Lafayette
8	2.25	Columbia, Dodge, Dane, Jefferson, Green, Rock
9	2.18	Ozaukee, Washington, Waukesha, Milwaukee, Walworth, Racine, Kenosha
[2]Bulletin 71: Rainfall Frequency Atlas of the Midwest, Midwest Climate Center and Illinois State Water Survey, 1992.		

Attachment 1:
Sample Sediment Basin Design Problem

The proper sizing and design of a sediment basin will often require iterative calculations. The technical standard for sizing sediment basins was written to give the designer as much flexibility as possible in designing the basin while meeting water quality requirements. The governing equation relates the surface area of the sediment basin to the outflow and critical particle settling velocity. The larger the sediment basin outflow, the larger the surface area required to settle the particle. As the outflow is reduced, a smaller surface area is required however the required storage volume dictates how small a surface area can become through the storage depth or hydraulic head acting on the outlet.

The particle settling velocities are listed in the standard requiring the designer to either start with a desired outflow based on an outlet size or an estimated starting surface area. The sample equation below starts with an estimated surface area.

Sample Problem:

A 10 acre site is being developed into condos. Eight acres of the site are being disturbed while 2 acres of forest are remaining undisturbed. The dominate soils on the site are silt loam. The 1-year, 24-hour design storm is 2.25 inches.

Step 1: Calculate runoff volume and peak using TR-55 or approved method.

From TR-55 the curve number (CN) for the disturbed area is 86 and the CN for the forested area is 55 resulting in a composite CN of 80. Using TR-55, the runoff volume calculated for the 1-year 24-hour design storm is 0.7 inches (0.6 acre-feet for the entire 10-acre site). The time of concentration was calculated as 0.4 hours resulting in a peak flow of 6 cfs.

Step 2: Begin sizing sediment basin using Equation 1. The technical standard lists silt loam under particle class 2 with a settling velocity of $7.3*10^{-5}$ ft/sec. We are also going to assume a starting surface area of 0.25 acres (10,890 ft^2). An alternative approach is to assume an outflow velocity.

$SA = 1.2 * (q_{out} / v_s)$
Solve for q_{out}: $10{,}980\ ft^2 = 1.2 * (q_{out} / 7.3*10^{-5}\ ft/sec)$
$q_{out} = 0.67$ cfs

Step 3: Using Figure 2: Approximate Detention Basin Routing for Type II Storms determines the volume of storage (V_S) needed.

$q_{out} = 0.67$ cfs (calculated in Step 2)
$q_{in} = 6.0$ cfs (peak flow calculated using TR-55 in Step 1)
$V_R = 0.6$ acre-feet (volume of runoff calculated using TR-55 in Step 1)
$q_{out} / q_{in} = 0.67$ cfs / 6.0 cfs = 0.11. Using Figure 2 with a $q_{out} / q_{in} = 0.11$, the V_S/V_R is determined to be 0.54. Therefore the $V_S = 0.54 * 0.6$ acre-feet = 0.324 acre-feet (14,113 ft^3)

Step 4: Check configuration: Calculate maximum head on outlet using surface area and volume.

SA = 10,890 ft^2 and a $V_S = 14{,}113\ ft^3$ we get a depth (H) of 1.29 feet = 14,113 ft^3 / 10,890 ft^2

Step 5: Size Outlet: Assuming an orifice type outlet calculate the size needed to meet the q_{out} calculated in Step 1 and the H calculated in Step 4.

Using the orifice equation: $q_{out} = C*A*(2gH)^{1/2}$ with C=0.6 (coefficient) , A = Area = ft^2, g = 32.2, and H = hydraulic head expressed in feet.

$q_{out} = 0.6*A*(2*32.2* H)^{1/2}$ so $0.66 = 0.6*A*(2*32.2*1.29)^{1/2}$ therefore A = .12 ft^2

An area of 0.12 ft^2 corresponds to an orifice outlet of 4.7 inches in diameter.

Step 6: Iteration: While the above solution works, the sediment basin has not been optimally sized and we have an orifice diameter that is not a standard pipe size. An iterative approach can be used to reduce the surface area of the sediment basin and obtain a more common orifice diameter. We can assume a 4-inch orifice since it is close to diameter calculated in Step 5 and we can start with the depth we calculated in Step 4. The iterations below each represent Steps 2 through 5.

Iteration 1:

$q_{out} = 0.43 (H)^{1/2} = 0.43 (1.29)^{1/2} = 0.48$ cfs which is less than the 0.66 cfs calculated in Step 1. Therefore, we can go back to Step 1 and repeat the sizing procedure and downsize the sediment basin.

$SA = 1.2 * (q_{out} / v_s) = 1.2 * (0.48 \text{ cfs} / 7.3*10^{-5} \text{ ft/sec}) = 7{,}890 \text{ ft}^2$

Using Figure 2:
$q_{out} = 0.48$ cfs
$q_{in} = 6.0$ cfs (peak flow calculated using TR-55 in Step 1)
$V_R = 0.6$ acre-feet (volume of runoff calculated using TR-55 in Step 1)

$q_{out} / q_{in} = 0.48 \text{ cfs} / 6.0 \text{ cfs} = 0.08$. Using Figure 2 with a $q_{out} / q_{in} = 0.08$, the V_S/V_R is determined to be 0.62. Therefore the $V_S = 0.62 * 0.6$ acre-feet = 0.372 acre-feet (16,204 ft^3)

SA = 7,890 ft^2 and a $V_S = 16{,}204$ ft^3 we get a depth (H) of 2.05 feet = 16,204 ft^3 / 7,890 ft^2

$q_{out} = 0.43 (H)^{1/2} = 0.43 (2.05)^{1/2} = 0.61$ cfs which is more than the 0.48 cfs we used so iterate.

Iteration 2:

$SA = 1.2 * (q_{out} / v_s) = 1.2 * (0.61 \text{ cfs} / 7.3*10^{-5} \text{ ft/sec}) = 10{,}027 \text{ ft}^2$

Using Figure 2:
$q_{out} = 0.61$ cfs
$q_{in} = 6.0$ cfs (peak flow calculated using TR-55 in Step 1)
$V_R = 0.6$ acre-feet (volume of runoff calculated using TR-55 in Step 1)

$q_{out} / q_{in} = 0.61 \text{ cfs} / 6.0 \text{ cfs} = 0.10$ Using Figure 2 with a $q_{out} / q_{in} = 0.10$, the V_S/V_R is determined to be 0.54. Therefore the $V_S = 0.54 * 0.6$ acre-feet = 0.324 acre-feet (14,113 ft^3)

SA = 10,027 ft^2 and a $V_S = 14{,}113$ ft^3 we get a depth (H) of 1.41 feet = 14,113 ft^3 / 10,027 ft^2

$q_{out} = 0.43 (H)^{1/2} = 0.43 (1.41)^{1/2} = 0.51$ cfs which is less than the 0.61 cfs we used so we are OK or we can iterate again until we have q_{out} that are almost identical.

After Iteration 2, we have a sediment basin with a SA = 10,027 ft^2 and a $V_S = 14{,}113$ ft^3. We have a principal water quality outlet consisting of a 4-inch orifice. This design meets the water quality requirements of the technical standard.

Temporary Grading Practices For Erosion Control

(Surface Roughening and Temporary Ditch Sumps)
(1067)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

Temporary[1] grading practices used to minimize construction site erosion. These practices include, but are not limited to surface roughening (directional tracking and tillage) and temporary ditch sumps.

II. Purpose

The purpose of these practices are to minimize erosion and sediment transport during grading operations on construction sites.

III. Conditions Where Practice Applies

These practices apply where land disturbing activities occur on construction sites. These practices shall be used in conjunction with other erosion control practices.

IV. Federal, State, and Local Laws

Users of this standard shall be aware of applicable federal, state, and local laws, rules, regulations, or permit requirements governing these practices. This standard does not contain the text of federal, state, or local laws.

V. Criteria

These interim practices may be employed in addition to the approved grading plan to reduce erosion and sediment transport.

A. Surface Roughening - Surface roughening is abrading the soil surface with horizontal ridges and depressions across the slope to reduce runoff velocities.

1. Directional Tracking - The process of creating ridges with tracked vehicles on unvegetated slopes. This method is used for short durations on sites actively being grad and shall be used in conjunction with other practices. This practice shall be in place at the end of each workday.

   Directional tracking involves driving a tracked vehicle up and down a slope. The tracks create horizontal grooves and ridges. The rough surface slows sheet runoff and helps to prevent rills from forming. (Conversely, if the tracked vehicle is driven along the contour the tracks create vertical grooves and ridges for the water to follow, increasing erosion.)

2. Tillage - Utilizing conventional tillage equipment to create a series of ridges and furrows on the contour no more than 15 inches apart.

B. Temporary Ditch Sump - Temporary ditch sumps are ½ to 5 cubic yard excavations made in a drainageway during earthmoving operations. Their purpose is to slow and pond runoff during the time that drainageways are being graded. Sumps shall be in place prior to anticipated rain events.

Construction involves excavating sumps (holes) in the rough ditch grade, and using the excavated material to form a dike on the downstream side of the sump.

Temporary ditch sumps are not effective perimeter controls. Other sediment control practices shall be utilized prior to channels discharging into public waterways.

VI. Considerations

A. Directional tracking may compact the soil, therefore additional seedbed preparation may be required. Refer to WDNR Conservation Practice Standard Seeding for

[1] Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Construction Site Erosion Control (1059) for seedbed preparation and seeding criteria.

B. When constructing a temporary ditch sump, compacting the dike provides additional stability.

C. Consider at a minimum excavating ½ cubic yard per 1% gradient, for every 500 feet of channel when constructing temporary ditch sumps

VII. Plans and Specifications

Due to the interim nature of these practices, and the fact that location determinations are made in the field, they need only be referenced in the erosion control plan narration or general notes.

VIII. Operation and Maintenance

These practices shall be inspected and repaired or reinstalled after every runoff event.

IX. References

Virginia Department of Conservation and Recreation. 1992. Virginia Erosion and Sediment Control Handbook, Third Edition. Chapter 3 – 3.29 Surface Roughening.

Dane County. 2002. Dane County Erosion Control and Stormwater Manual, First Edition. Appendix Surface Roughening S-16.1.

X. Definitions

Temporary (I): An erosion control measure that is utilized during construction site grading activities.

Dust Control On Construction Sites
(1068)

Wisconsin Department of Natural Resources
Conservation Practice Standard

I. Definition

Dust control includes practices used to reduce or prevent the surface and air transport of dust during construction.

Dust control measures for construction activities include minimization of soil disturbance, applying mulch and establishing vegetation, water spraying, surface roughening, applying polymers, spray-on tackifiers, chlorides, and barriers.

II. Purpose

This practice may be used to:

- Reduce wind erosion and dust.
- Minimize deposition of dust and wind transported soils into water bodies through runoff or wind action.
- Reduce respiratory problems.
- Minimize low visibility conditions caused by airborne dust.

III. Conditions Where Practice Applies

Dust control measures may be applied at any construction site, but is particularly important for sites with dry exposed soils which may be exposed to wind or vehicular traffic.

IV. Federal, State, and Local Laws

Users of this standard shall comply with applicable federal, state and local laws, rules, regulations or permit requirements governing this practice. This standard does not contain the text of federal, state, or local laws.

V. Criteria

This section establishes the minimum standards for design, installation and performance requirements.

A. The implementation of dust control shall limit the area exposed for dust generation.

B. Asphalt and petroleum based products cannot be used for dust control.

C. Mulch and Vegetation - Mulch or seed and mulch may be applied to protect exposed soil from both wind and water erosion. Refer to WDNR Conservation Practice Standards Mulching for Construction Sites (1058) and Seeding for Construction Site Erosion Control (1059) for criteria.

D. Water - Water until the surface is wet and repeat as needed. Water shall be applied at rates so that runoff does not occur. Treated soil surfaces that receive vehicle traffic require a stone tracking pad or tire washing at all point of access. Refer to WDNR Conservation Practice Standard Stone Tracking Pad and Tire Washing (1057) for criteria.

E. Tillage - A control measure performed with chisel type plows on exposed soils. Tillage shall begin on the windward side of the site. Tillage is only applicable to flat areas.

F. Polymers - Polymers can be an effective practice for areas that do not receive vehicle traffic. Dry applied polymers must be initially watered for activation to be effective for dust control. Refer to WDNR Conservation Practice Standard Erosion Control Land Application of Polymers (1050) for application criteria.

G. Tackifiers and Soil Stabilizers Type A - Products must be selected from and installed at rates conforming to the WisDOT Erosion Control PAL. See Section IX for reference. Example products include Latex-based and

Guar Gum.

H. Chlorides - Chlorides shall be applied according to the most recent version of the WisDOT Standard Specifications for Highway and Bridge Construction.

I. Barriers - Barriers shall be placed at right angles to prevailing wind currents at intervals of about 15 times the barrier height. Solid board fences, snow fences, burlap fences, crate walls, bales of hay and similar material can be used to control air currents and blown soil.

VI. Considerations

Some sites may require an approach that utilizes a combination of measures for dust control.

VII. Plans and Specifications

Plans and specifications for dust control practices shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

VIII. Operation and Maintenance

Areas that have dust control practices shall at a minimum be inspected daily.

IX. References

WisDOT's Erosion Control Product Acceptability List (PAL) can be found on the WisDOT web site: http://www.dot.wisconsin.gov/business/engrserv/pal.htm Printed copies are no longer being distributed.