TECHNICAL SERVICE AREA 8

Providing Engineering and Technical Assistance to North Central MN SWCDs

CONSTRUCTION AND MATERIALS SPECIFICATIONS FOR

KINGS LAKE WATER CONTROL STRUCTURE T 58 N - R 24 W - SEC 4

ITASCA SOIL & WATER CONSERVATION DISTRICT

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Lake of the Woods | Koochiching | Beltrami | Clearwater | Itasca | Hubbard | Cass | Wadena | Crow Wing

CONSTRUCTION SPECIFICATIONS

MNDOT Spec 2104 Removing Pavement and Miscellaneous Structures
MNDOT Spec 2105 Excavation and Embankment
MNDOT Spec 2461 Structural Concrete
MNDOT Spec 2472 Metal Reinforcement
MNDOT Spec 2501 Pipe Culverts
MNDOT Spec 2511 Rip Rap
MNDOT Spec 2557 Fencing
MNDOT Spec 2573 Storm Water Management
MNDOT Spec 2574 Soil Preparation
MNDOT Spec 2575 Establishing Vegetation and Controlling Erosion

MATERIAL SPECIFICATIONS

MNDOT Spec 3248 Polyvinyl Chloride Pipe
MNDOT Spec 3301 Reinforcement Bars
MNDOT Spec 3379 Fence Gates
MNDOT Spec 3403 Hot-Rolled Steel Fence Posts
MNDOT Spec 3406 Structural Metal Fence Posts
MNDOT Spec 3601 Rip Rap Material
MNDOT Spec 3876 Seed
MNDOT Spec 3877 Topsoil Material
MNDOT Spec 3885 Rolled Erosion Control Products
MNDOT Spec 3887 Floatation Silt Curtain
MNDOT Standard Plate 9322K Chain Link Fence: Steel Posts – Line Posts
MNDOT Standard Plate 9322K Chain Link Fence: Gates
Material Specification 584 Structural Timber and Lumber
Material Specification 585 Wood Preservatives and Treatment
Agri-Drain Rat Guard

I hereby certify that this plan and specification was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

William K. Westerberg

William K. Westerberg

Date: 9-27-19

Lic. # 21874

2104 REMOVING PAVEMENT AND MISCELLANEOUS STRUCTURES

2104.1 DESCRIPTION

This work consists of removing and disposing of pavement, sewers, culverts, guardrails, abandoned structures, and other obstructions on the right-of-way, except as specified in 2442, "Removal of Existing Bridges," and 2103, "Building Removal." This work also consists of salvaging material and backfilling trenches, holes, and depressions.

2104.2 MATERIALS — (BLANK)

2104.3 CONSTRUCTION REQUIREMENTS

A General

Remove and dispose of structures and obstructions as required by the contract.

B Salvage Operations

Remove, dismantle, and store salvaged materials to allow re-use.

When salvaging guardrail and fences, coil the wire and cable, pull posts from the ground, and remove nails and staples from posts and boards.

Stockpile materials designated for salvage by the Department on the right-of-way at locations approved by the Engineer. Remove, dismantle, and clean materials as required by the contract before stockpiling.

C Removal Operations

C.1 Removing Portion of Structure

Do not damage existing structures to be retained for use during the removal operations. Ensure a length of at least 40 bar diameters from the face of the cut for existing reinforcement bars for concrete structures left in place.

C.2 Pavements and Sidewalks

Saw the existing concrete pavement or sidewalks or bituminous pavement at the locations as shown on the plans and as staked by the Engineer to establish a neat line for extending the new work.

C.3 Concrete and Masonry Structures

Remove concrete and masonry structures to the excavation limits as shown on the plans.

Remove septic tanks, cisterns, and cesspools.

Rebuild and reconnect live sewers after removing related manholes, catch basins, and drop inlets. Provide a by-pass and maintain the service during the removal operations.

Use concrete or masonry plugs to plug pipes draining into abandoned basements, manholes, or similar structures.

C.4 Timber Structures and Underground Tanks

Remove timber structures and underground tanks meeting the requirements of applicable laws and regulations.

C.5 Wells and Holes

Refer to Minnesota Rules, Chapter 4725, "Wells and Borings," for the definition of "wells" and "borings." Construct and seal most wells and borings meeting the requirements of Minnesota Rules, Chapter 4725, "Wells and Borings."

Seal wells and borings taken out of service meeting the requirements of Minnesota Rule Chapter 4725, "Wells and Borings." Protect wells and borings until permanently meeting the requirements of Minnesota Rule Chapter 4725, "Wells and Borings," during the work to prevent surface drainage from entering the opening. Cut and remove casing in the well or boring to the elevation as shown on the plans or as directed by the Engineer after sealing. Submit one copy of the sealing record to the Minnesota Department of Health and one copy to the Engineer within 30 calendar days after sealing a well or boring.

C.6 Miscellaneous Items

When removing railroad tracks, remove rails, ties, paving, crossings, track encasements, and other appurtenances.

D Disposal of Materials and Debris

D.1 Disposal Plan

Provide the Engineer with information and documentation substantiating proper disposal arrangements and operations. The Department will not pay for removal before acceptance of the initial disposal plan or, if required, a modified disposal plan.

D.2 Disposal within Right-of-Way

Do not dispose material or debris within the right-of-way. Do not burn or bury treated or untreated wood, including but not limited to dimensional lumber, brush, trees, and roots, within the right-of-way.

D.3 Disposal outside Right-of-Way

Dispose of materials and debris, resulting from removal or demolition operations having no specific disposal provisions, outside the right-of-way.

Assume full responsibility for acceptable disposition of the material and for damages resulting from the disposal operations.

The Engineer may not give final acceptance of the work:

(1) Unless disposal is made at a publicly controlled dumping site, or
(2) Until the disposal areas are in acceptable condition with respect to the Contractor's obligations.

E Backfilling Depressions

Backfill depressions with material in accordance with 2105, "Excavation and Embankment."

2105 EXCAVATION AND EMBANKMENT

2105.1 DESCRIPTION

This work consists of excavating and placing embankment.

A Definitions

A.1 Road Core

The road core is the area below the grading grade to the bottom of the excavation and between the following:

(1) For embankment heights ≤ 30 ft., from the grading grade point of intersections (P.I.s) with a 1:1 (V:H) slope and
(2) For embankment heights > 30 ft., from the grading grade point of intersections (P.I.s) with a 1:1½ (V:H) slope.

A.2 Grading Grade

Grading grade is the bottom of the aggregate base.

A.3 Top of Subgrade

The top of the subgrade is the surface of material immediately beneath the granular material. If there is no granular layer, then the top of subgrade is the Grading Grade.

A.4 Optimum Moisture Content

The optimum moisture content is determined by the:

- Moisture Density Test Method (Proctor), or
- One-Point Proctor Method, or
- Estimated Optimum Moisture Content Form G&B-305.

A.5 Maximum Density

Maximum density is the maximum density determined by the Moisture Density Test Method (Proctor) test in the Grading and Base Manual.

A.6 Select Grading Material

Select grading **materials** are all mineral soils found in the Triaxial Chart in the Grading and Base Manual, excluding silt. Silt is defined as soils containing 80% or more silt-sized particles. Marl and organic soils are also excluded.

A.7 Granular Materials

Granular materials meet the requirements of 3149.2.B.1.

A.8 Non-Structural Grading Materials

Non-Structural grading materials are all mineral soils, excess topsoil, and organic soils, capable of supporting construction equipment.

A.9 Uniform Soils

Uniform soils have the same soil class per the Triaxial Chart in the Grading and Base Manual and have similar color, moisture content, and performance characteristics.

A.10 Organic Soils

Organic soils contain ≥ 5 percent organic content.

A.11 Geotextiles for Separation

A geotextile used for separation at the location(s) shown in the plan, or as directed by the Engineer. Geotextiles provide separation between the fill and underlying softer soils, prevent mixing, provide stability during compaction, provide reinforcement, and minimize differential movement.

2105.2 MATERIALS

A Excavation Material

The Engineer will classify the excavation using the following categories:

A.1 Common Excavation

Material not classified in any other category.

A.2 Subgrade Excavation

All excavation in the road core below a paved surface (concrete, bituminous, and all other stabilized bituminous surfaces as defined in 2104, "Removing Pavement And Miscellaneous Structures", excluding rock, muck, channel, or rock channel excavation.

A.3 Rock Excavation

Material that requires drilling, blasting, or ripping before excavation. This includes boulders and other detached rock larger than 1 cu. yd.

A.4 Muck Excavation

The removal of organic soils as defined in 2105.1.A.10, "Organic Soils," and other unstable soils as designated by the plan, and below the natural ground level of marshes, swamps, or bogs, regardless of the moisture content. Muck excavation is limited to areas over which the roadway embankment or a structure is to be constructed.

A.5 Channel and Pond Excavation

Material from channel changes, waterways, and ponds outside of the roadway embankment not classified as rock channel excavation.

A.6 Rock Channel Excavation

Material classified as rock excavation from channel changes and waterways outside of the roadway embankment.

A.7 Topsoil Excavation

All excavation material taken from the top of an exposed layer of soil that supports vegetation and is salvaged, stockpiled, and used in accordance with 2574, "Soil Preparation."

B Borrow Material

Provide borrow meeting the specifications in Table 2105-1.

Table 2105-1
Borrow Specifications

Material	Specification
Common Borrow	2105.1.A.6, "Select Grading Material"
Granular Borrow	3149.2.B.1, "Granular Material"
Select Granular Borrow	3149.2.B.2, "Select Granular Material"
Topsoil Borrow	3877, "Topsoil Material"

Materials obtained by the Contractor from sources outside the roadway must comply with 1601, "Source of Supply and Quality," and with 1602, "Natural Material Sources."

C Geotextiles

Geotextiles conforming to 3733, "Geotextiles".

D Stabilizing Aggregate

Aggregate meeting the requirements of 3149.2.C.

2105.3 CONSTRUCTION REQUIREMENTS

A General

For road core embankment meet the requirements of select grading material per 2105.1.A.6.

Non-structural grading materials per 2105.1.A.8 may be used as embankment outside the road core.

All forms and the Grading and Base Manual are available on the Grading and Base Website. Unless otherwise designated, all test procedures are in the Grading and Base Manual.

Perform excavation and embankment operations within the plan excavation limits as required by the contract.

Before beginning excavation and embankment operations, comply with the requirements of 2101, "Clearing and Grubbing."

Comply with the erodible surface requirements of 2574, "Soil Preparation."

Maintain drainage in excavations and embankment operations at all times. Provide and maintain temporary drainage facilities until the permanent facilities are complete and operational.

Provide and maintain temporary preparation and erosion control on embankment and stockpiles until finishing operations per 2105.3.H are complete.

Repair or replace settlement plates damaged by Contractor operations or negligence.

Protect structures during construction operations. Repair structures damaged by Contractor operations.

Excess materials from within the excavation limits shown on the plans that meet the specified requirements can be used by the Contractor for borrow items shown on the plans. These excess materials must comply with 1405, "Use of Materials Found on the Project."

If the plans show a contract pay item for stabilizing aggregate place it in accordance with 2211, "Aggregate Base".

B Contractor Quality Control (QC) Testing

Perform Contractor QC testing and submit all required forms, if required in the Schedule of Materials Control.

Submit results to the Engineer within one business day after sampling.

Test corrected areas that fail either QC or Quality Assurance (QA).

Submit to the Engineer the following items:

- a preliminary Grading and Base Report (G&B-001) (required before work commences),
- a final Grading and Base Report (G&B-001) (required within two weeks of completion of project), and

- a weekly summary report of tests completed and retests of failing materials (G&B-003) (required the first working day of the following week).

B.1 Aggregate Certification and Aggregate Testing

Certify granular materials on Form G&B-104. Attach any required aggregate test results to Form G&B-104.

Material placed without certifications is unauthorized work in accordance with 1512, "Unacceptable and Unauthorized Work."

Gradation, quality, and crushing testing are only required for 1906.2, "Material On Hand".

B.2 Moisture Control

If required by the Schedule of Materials Control, determine the optimum moisture content.

Test for the moisture content in areas that appear least likely to meet specifications.

Determine the moisture content during compaction using test methods listed in the Grading and Base Manual or by alternate methods approved by the Engineer.

Meet the moisture content requirements listed in Table 2105-2.

Table 2105-2
Moisture Content Requirements

For Compaction Requirements	Relative Moisture Content Requirements*
Minimum of 100% of maximum density	65% – 102%
Minimum of 95% of maximum density	65% – 115%
Quality Compaction	65% – 102%
Penetration Index Method	≥ 65%
* As determined on form G&B-105	

Correct for moisture content in areas represented by failing moisture tests, before testing the compaction. Compaction tests taken in areas represented by failing moisture tests are not valid.

Note that optimum moisture content determination tests and moisture tests during compaction are required for all compaction requirements, including quality compaction, LWD, penetration index, and specified density.

B.3 Proctor Tests

The Contractor uses the Department's proctor test results for optimum moisture determination.

B.4 Test Rolling

Test roll, per the Schedule of Materials Control and Contract, the top surface of non-granular subgrade and the top of any granular surface not meeting the requirements of 3149.2.B.2 per 2111 using the test roller as specified in the Contract. If no test roller is specified, use test roller TR10.

C Preparation of Embankment Foundation

When slopes are steeper than 1:4 (V:H), construct steps before placing embankment material. Construct the steps with a minimum width of 12 in and a maximum height of 24 inches.

Ensure the foundation area drains freely.

Compact the bottom of the excavation according to Table 2105-3.

Table 2105-3
Required Compaction for Bottom of Excavation

Excavation Depth Below Grading Grade *	Material Type	Required Compaction
All depths Structure Backfill	Non-Granular	100% of maximum density, LWD, and Quality Compaction
All depths Structure Backfill	Granular	100% of maximum density, LWD, Penetration Index, and Quality Compaction
< 30 in	Non-Granular	100% of maximum density, LWD, and Quality Compaction
< 30 in	Granular	100% of maximum density, LWD, Penetration Index, and Quality Compaction
≥ 30 in	Non-Granular	95% of maximum density or 4 passes of a roller †
≥ 30 in	Granular	100% of maximum density, LWD, Penetration Index, and Quality Compaction

*: Excavation below the planned subgrade may be subject to 1402, "Contract Revisions"
†: Use a pad foot roller weighing at least 25,000 lb. The Engineer may waive the four pass requirement if the subgrade will not support the roller or direct the Contractor to repair the subgrade. Repairs are subject to 1402.5, "Extra Work".

Remove surfacing and excavate an existing road core in accordance with the Contract. Then perform subgrade preparation on the excavated portion and the new roadcore in accordance with 2112, "Subgrade Preparation," before placing new embankment material.

D Excavating Operations

Obtain the Engineer's written approval before excavating beyond the limits and elevations established by the contract.

Remove rock outcroppings from within the slope lines and to the elevations shown on the plans. Remove loosened rock from the backslopes. Provide drainage for the shoulder slopes. Do not leave undrainable depressions.

Presplit rock back slopes steeper than 1:1 (V:H). Control blasting operations to eliminate flying rock or debris.

Excavation below the planned subgrade to correct unstable conditions may be subject to 1402, "Contract Revisions"

E Placing Embankment Materials

Place embankments in uniform lifts, parallel to the plan profile grade, over the full width of the roadway. Construct each lift of material using uniform soil.

Protect structures during placement of embankments.

Place granular materials in the uppermost portion of the subgrade.

Excavate, stockpile, and place topsoil as required by the contract.

Obtain written permission from the Engineer before removing topsoil or granular material from the project.

Embankment materials placed on the road core may not increase the moisture content of the underlying material beyond the specified limit

Maximum lift thicknesses are controlled by the capability of the equipment to uniformly compact the entire lift in accordance with the following:

(1) For all areas, except for structural backfill, the Engineer will restrict lift thickness to no greater than 12 in (loose thickness), when uniform results are not achieved.
(2) For structural backfill, the maximum lift thickness is 6 in compacted (8 in loose) thickness.
(3) The Engineer may allow thicker lifts over saturated foundation soils. The top of the thicker lift must be at least 4 ft. below the grading grade.

Uniformly blend the entire thickness of each lift before testing moisture content and compaction. Disc soils with greater than 20 percent passing the No. 200 sieve.

Stagger construction traffic uniformly over the full width of the roadway embankment.

Remove snow, ice, and frozen soils from road core before placing embankment.

Use embankment material in the road core with particle sizes no larger than specified in Table 2105-4:

Table 2105-4
Maximum Particle Size in Road Core

Depth from Grading Grade	Maximum Particle Size Inches
< 12 in	3
1 ft. – 3 ft.	6
3 ft. – 6 ft.	12
> 6 ft.	24
≤ 2 ft. from a non-plastic structure	3
≤ 2 ft. from a plastic structure	1
Areas where piling is to be placed	6

Remove surcharges as directed by the contract.

Install settlement plates, if required by the contract. Do not disturb settlement plates.

F Compacting Embankments

Maintain moisture content during compaction per Table 2105-2.

Correct the moisture in areas represented by failing tests before testing the compaction.

Compaction tests taken in areas represented by failing moisture tests are not valid.

Meeting the requirements of 100% density for the specified density method is equivalent to meeting the requirements for the penetration index method.

Uniformly compact each lift of the road core,

For materials not meeting the requirements of 3149.2.B.1, "Granular Materials":

- to the specified density requirements per 2105.3.F.1,
- the quality compaction requirements per 2105.3.F.2, and
- the LWD requirements of 2105.3.F.4

For materials meeting the requirements of 3149.2.B.1, "Granular Materials":

- to the specified density requirements per 2105.3.F.1,
- the quality compaction requirements per 2105.3.F.2,
- the penetration index (PI) requirements per 2105.3.F.3, and
- the LWD requirements of 2105.3.F.4

Compact all roadway embankment outside of the road core to the quality compaction requirements per 2105.3.F.2.

Compact the entire length and width of each lift with a roller. Construction traffic does not replace the rolling requirement.

Compaction requirements on swamp backfills start when the road core embankment is 4 ft. above the water elevation at the time of construction operations.

The Engineer may waive mechanical compaction requirements on embankment containing predominately rock.

Compact soils around structures with appropriate equipment or hand methods to prevent damage to adjacent structures.

Correct or replace materials in areas represented by a failing test.

Maintain the required compaction until the next layer is placed.

F.1 Specified Density

Compact to meet the requirements of Table 2105-5.

Table 2105-5 Specified Density Requirements	
Embankment Location	**Required Compaction (Relative Density)**
≤ 3ft Below Grading Grade of Road Core, trails, or sidewalks for non-granular materials, and for all depths of subgrade preparation and granular materials	100% Minimum
> 3ft Below Grading Grade of Road Core, trails, or sidewalks for non-granular materials	95% Minimum
Within an excavation trench and backfill of structures, 2451, "Structural Excavations and Backfills", for all depths both within and out of road core. *	100% Minimum
* See plan sheets for modifications, note especially compaction requirements directly beneath pipes, where no compaction may be required.	

F.2 Quality Compaction

Compact each lift until there is no evidence of consolidation during compaction or under traffic, with no:

- Pumping – vertical displacement of the top surface of the compacted layer, not directly under the vehicle tire
- Reaction – a movement back to a former or less advanced condition.
- Yielding – giving under pressure (flexible)
- Cracking – cracking of material on visible surface
- Lateral movement – sideways movement of the top surface

F.3 Penetration Index (PI)

Compact the entire lift to achieve a dynamic cone penetration index (DPI) value per Table 2105-6.

Table 2105-6 Maximum Allowable Penetration for DCP			
Grading Number †	**Moisture Content ‖**	**Maximum Allowable DPI, *mm/blow***	**Maximum Allowable Seat**
3.1 – 3.5	< 5.0	10	No Requirement
	5.0 – 8.0	12	
	> 8.0	16	
3.6 – 4.0	< 5.0	10	
	5.0 – 8.0	15	
	> 8.0	19	
4.1 – 4.5	< 5.0	13	
	5.0 – 8.0	17	
	> 8.0	21	
4.6 – 5.0	< 5.0	15	
	5.0 – 8.0	19	
	> 8.0	23	
5.1 – 5.5	< 5.0	17	
	5.0 – 8.0	21	
	> 8.0	25	
5.6 – 6.0	< 5.0	19	
	5.0 – 8.0	24	
	> 8.0	28	
† As determined by Form G&B-203 ‖ Percent of dry weight. Note that a moisture test is not required, if the material meets the toughest requirements for the Grading Number.			

F.4 Light Weight Deflectometer (LWD) Method

Compact the entire lift to achieve the LWD target value as required per the LWD procedure for 2105 in the Grading and Base Manual.

G Agency Quality Assurance (QA)

Test according to the Schedule of Materials Control. Note: Test for moisture control per 2105.3.B.2, if required by the Schedule of Materials Control.

G.1 Material Testing

Perform the following QA tests:

(1) Gradation,
(2) Crushing,
(3) Aggregate Quality, and
(4) Bitumen content (using procedure 1852 in the Laboratory Manual).

Sample the granular materials from the road core after spreading but before compaction.

Select crushing, aggregate quality, and bitumen samples using the random sampling method in the Grading and Base manual; additional samples and tests may be taken to delineate visually indicated material failures. Select gradation samples from locations that are at risk of not meeting the specification requirements.

G.2 Compaction Testing

Test for compaction using:

- Quality compaction, and specified density or the LWD for materials not meeting the requirements of 3149.2.B.1, "Granular Materials", or
- Quality compaction, and specified density or granular penetration index or the LWD for materials meeting the requirements of 3149.2.B.1, "Granular Materials."

Test for compaction in areas with the greatest rutting or deflection, and near structures, and in an area at least 1 foot from an unconfined edge.

Correct any area represented by a failing test. Perform additional tests in areas with the greatest rutting or deflection.

For clean granular materials with less than 6% passing the #200 sieve, the Engineer may elect to only use the Quality Compaction method, 2105.3.F.2.

Use the specified density method for virgin materials only.

The following method may be used in lieu of point testing (penetration index, specified density, or LWD) for material meeting 3149.2.B.2, "Select Grading Material", when the material thickness is 18" or less and when not adjacent to Structures per 1101, "Definitions".

The Engineer may elect, with the concurrence of the Contractor, to have the Contractor test roll per 2111, "Test Rolling", material meeting the requirements of 3149.2.B.2, "Select Granular Material", in lieu of point compaction testing. If this method is adapted, the Contractor would be required to first place 3" of base on top of the material meeting 3149.2.B.2 prior to test rolling. For areas failing test rolling the Contractor would be required to remove the base and recompact the material meeting 3149.2.B.2, then place the base back, and retest roll. There is no additional compensation to the Contractor, if this method is adapted. Additionally, the material meeting 3149.2.B.2 is not accepted, until acceptable test rolling has occurred.

G.3 Test Rolling

Observe and document all test rolling, per the Schedule of Materials Control and Contract.

H Finishing Operations

Shape and maintain the roadway core to the required grade and cross section and within the tolerance in accordance with 2112.3.E, "Tolerances" until the next layer is placed.

Perform earthwork finishing and topsoil placement operations concurrently to allow timely completion of erosion control items. Shape and maintain disturbed areas outside the road core to final grade prior to placing erosion control. Scarify the surface to a minimum depth of 3 in before placing topsoil. Complete soil preparation, erosion control, and turf establishment, as required by 2574, "Soil Preparation" and 2575, "Establishing Turf and Controlling Erosion".

I Disposition of Excavated Material

All surplus materials become the property of the Contractor. Dispose of these materials in accordance with a disposal plan approved by the Engineer. The disposal plan must comply with all applicable environmental regulations, permit requirements, and 2104, "Removing Pavement and Miscellaneous Structures". Disposal of materials before acceptance of the disposal plan is unauthorized work in accordance with 1512, "Unacceptable and Unauthorized Work".

J Hold Point

Any failure to meet a requirement creates a Hold Point, whereby no additional material may be placed until Corrective action and passing retest(s) have occurred, or accepted by the Engineer. All additional material placed before corrective action and passing retest(s) occur constitutes Unauthorized Work per 1512.2.

K Geotextile Requirements

Submit the proposed construction sequence for geotextile and fill placement to the Engineer for review at least 21 days prior to beginning of this element of construction. Place geotextiles, if required in the plan or if directed by the Engineer.

Prepare a smooth surface, free of stones, sticks, or other debris or irregularities that may puncture or tear the geotextile. Unless otherwise directed or approved by the Engineer, place the geotextile with the highest strength direction (usually the "machine" or roll direction) oriented in the direction of the greatest expected field stress (this will usually be at right angles to the centerline of the construction).

If multiple pieces of geotextile are required, field or factory sew adjacent strips, with the seams meeting the strength as specified in 3733.2B. Use a "double spool" machine capable of sewing a Federal Type 401 locking stitch. Sow a flat, "J", or butterfly seam type, using thread with a minimum strength of strength of 25 pounds with 1-2 rows of stitching and 5-7 stitches per inch, and consistent with achieving the required seam strength and as recommended by the geotextile manufacturer.

Approved adhesive listed on the MnDOT approved/qualified products list may be used in lieu of sewing for Types 1, 2, 3, 4, and 5 geotextiles. The approved list for adhesives is found under the geosynthetic heading. Install per the Adhesive Seams Guidelines found on the geosynthetic/adhesive seams links on the MnDOT approved/qualified products list.

Secure the geotextile so that it is not displaced during subsequent construction. Permit no traffic or construction equipment to operate directly on the geotextile. Repair any damaged geotextile to the satisfaction of the Engineer by patching and sewing.

Place fill onto the fabric in uniform lifts as required by the applicable specification, but in no case exceed 12 inches. Use fill material as shown in the plan or as directed by the Engineer. Use granular materials for placement from 2 feet above water level and below.

2461 STRUCTURAL CONCRETE

2461.1 DESCRIPTION

This work consists of producing, providing, placing, curing, and protecting cast-in-place portland cement concrete for placement in structures, pavements and incidental construction.

2461.2 MATERIALS

A Cementitious Materials

Provide cementitious materials from certified sources listed on the Approved/Qualified Products list.

Use Type I, I/II, IS, IL, or IP cement to produce Type 1 non-air-entrained concrete.

Use Type I, I/II, IS, IL, or IP cement and an air-entraining admixture listed on the Approved/Qualified Products List to produce Type 3 air-entrained concrete.

Use Type III portland cement as allowed by the contract or the Engineer.

A.1 Portland Cement.....3101

A.2 Slag Cement.....3102

A.3 Blended Hydraulic Cement.....3103

A.4 Fly Ash.....3115

A.5 Ternary Mixes

Ternary mixes are defined as portland cement or Type IL and two other supplementary cementitious materials, or blended cement and one other supplementary cementitious material.

B Aggregates

Provide aggregates from sources listed on the MnDOT Concrete Aggregate Properties list.

B.1 Fine Aggregate.....3126

B.2 Intermediate Aggregate.....3131

B.3 Coarse Aggregate.....3137

C Blank

D Water.....3906

Provide water from potable sources.

The Concrete Engineer will allow clarified water as a substitution for potable water in accordance with the following:

(1) From the Approved/Qualified Products list,
(2) In any concrete defined as MnDOT Grades B, F, G, M, P, and R,
(3) Up to a maximum of 50.0% of total mix water by weight,
(4) Provided the clarified water is identified separately on the Certificate of Compliance.

E Concrete Admixtures.....3113

Provide admixtures from the Approved/Qualified Products list for all concete grades shown in Table 2461-6 and Table 2461-7.

Use of any of the following admixtures are at the Contractor's discretion:

(1.1) Type A, Water Reducing Admixture
(1.2) Type B, Retarding Admixture
(1.3) Type D, Water Reducing and Retarding Admixture
(1.4) Type F, High Range Water Reducing Admixture
(1.5) Type G, High Range Water Reducing and Retarding Admixture
(1.6) Type S, Specific Performance Based Admixture

Use of the following accelerating admixtures require approval of the Concrete Engineer, in conjunction with the Engineer, unless otherwise allowed in the Contract:

(2.1) Type C, Accelerating Admixture
(2.2) Type E, Water Reducing and Accelerating Admixture

The Engineer will permit the use of Type C or Type E accelerating admixtures when all of the following conditions exist:
(3.1) The ambient temperature is below 36 °F,
(3.2) An Engineer approved cold weather protection plan is in-place, and
(3.3) Cold weather protection materials are on-site and ready for use.

F Concrete Mix Designs

F.1 Classification of Concrete

The Department will classify concrete by mix number to identify type, grade, consistency and aggregate size, if any, in accordance with Table 2461-1.

Table 2461-1
Mix Number Identification

First Digit	Second Digit	Third Digit	Fourth Digit	Additional Digits
Type Designation	Grade Designation	Maximum Slump	Coarse Aggregate Gradation Designation	Additional Digits Allowed or as Specified

F.1.a Type Designation

Provide Type 1 or Type 3 concrete in accordance with Table 2461-2:

Table 2461-2
Concrete Type Designation

Concrete Type	Target Air Content *
1	2.0 %
3	6.5 % ‖

* For concrete mix design purposes only.
‖ Unless otherwise required by 2301 or elsewhere in the contract.

F.1.b Grade Designation

The Department will designate concrete grade in accordance with Table 2461-6 and Table 2461-7 using a letter designating the following:
(1) Intended Use
(2) Maximum water/cement (w/c) ratio
(3) Maximum Cementitious Content
(4) Maximum Supplementary Cementitious Substitution (SCM)
(5) Slump range
(6) Minimum 28-day compressive strength, f'c
(7) Coarse Aggregate Quality in accordance with 3137

F.1.c Slump Designation

The Department will designate the slump range as defined by the Grade Designation in accordance with Table 2461-6 and Table 2461-7.

F.1.d Coarse Aggregate Gradation Designation

Select the appropriate coarse aggregate gradation designation in accordance with Table 2461-3 based on the intended use and the gradation requirements in 3137, "Coarse Aggregate for Portland Cement Concrete."

Table 2461-3
Coarse Aggregate Gradation Designation for Concrete

Designation	Coarse Aggregate Gradation
0	Job Mix Formula (JMF) combination of fine and coarse aggregate
	Table 3137-4, "Coarse Aggregate Designation for Concrete"
1	ASTM #467
2	ASTM #67
3	ASTM #7
4	ASTM #89
7	CA-70
8	CA-80

F.1.e Additional Concrete Mix Designation Digits

Specialty concrete mixes require additional concrete digits in accordance with Table 2461-6. Use "EX" for exposed aggregate mixes and "CO" for colored concrete mixes. The Contractor may add additional digits to the right of the required digits in the concrete mix number. **Need to add a note**

F.2 Concrete Mix Design Requirements

The Engineer determines final acceptance of the concrete for payment based on test results, satisfactory field placement and performance.

F.2.a Department Designed Concrete Mixes

The Department will provide mix designs for the concrete defined in Table 2461-4 and Table 2461-5.

F.2.a(1) Department Designed Concrete Requirements

No additional submittal is required for Table 2461-4 mix designs.

Table 2461-4
Department Designed Concrete Mixes

Type of Concrete	Mix Number	Specification	Mix Design Location
Field Batched Patching Mix	3U18	2302	Table 2302-1
Low Slump Concrete	3U17A	2404	Weekly Report of Low Slump Concrete
Bagged Patching Mix	3U18 and 3U58M	3105	Table 3105-1

F.2.a(2) Grout and Lean Mix Backfill

Submit final mix design proportions on the *General Concrete Mix Design Submittal* for Grout and Lean Mix Backfill in accordance with Table 2461-5.

Table 2461-5
Concrete Mix Design Requirements for Grout and Lean Mix Backfill Mixes

Mix Number	Maximum w/c ratio	Water Content (pounds)	Cement Content (pounds)	Fly Ash Content (pounds)	Fine Aggregate Calculation (pounds)	Coarse Aggregate Calculation (pounds)	%Air Content	Slump Range	Minimum 28-day Compressive Strength, f'c
1AGROUT *	0.50	379	758	0	100% †	0	3.0%	As needed	4000 psi
3AGROUT *	0.44	379	865	0	100% †	0	10.0%	As needed	4000 psi
Lean Mix ‖	1.00	375	125	250	50% †	50% † ǂ	N/A	10 in ± 1 in	75 – 400 #

* Do not provide grout containing coarse aggregate or fly ash.
‖ Coarse Aggregate Quality meets requirements of 3137.2.D.1, "Coarse Aggregate for General Use."
† After adding the specified quantities of cement, fly ash, and water, provide the remaining aggregate to an absolute volume 27.00 – 27.27 cu. ft.
ǂ Meeting ASTM #67 gradation as shown in Table 3137-4
\# Unconfined compressive strength range

F.2.b Contractor Designed Concrete Mixes

The Contractor will provide concrete mix designs for concrete defined in Table 2461-6 and Table 2461-7 and elsewhere as specified in the Contract.

The Contractor assumes full responsibility for the mix design and performance of the concrete.

F.2.b(1) General Concrete Mix Design Requirements

The Department defines the concrete mix design requirements for Contractor Designed Mixes in accordance with Table 2461-6.

Table 2461-6
Concrete Mix Design Requirements (Not applicable to High Performance Concrete or Mass Concrete)

Concrete Grade	Mix Number	Intended Use *	Maximum w/c ratio †	Maximum Cementitious Content (lbs/yd³)	Maximum %SCM (Fly Ash/ Slag/Ternary)	Slump Range	Minimum 28-day Compressive Strength, f'c	3137 Spec.
B Bridge Substructure	3B52 ‡	Abutment, stems, wingwalls, paving brackets, pier columns and caps, pier struts	0.45	750	30/35/40	2 - 5"	4000 psi	2.D.1
F Flatwork	3F32 ‡	Slipform curb and gutter	0.42	750	30/35/0	½ - 3" #	4500 psi	2.D.1
	3F52 ‡ 3F52EX 3F53EX 3F52CO ‖	Walks, curb and gutter, slope paving, median walks, driveway entrances, ADA pedestrian walks	0.45	750	25/30/0	2 - 5"	4500 psi	2.D.1
G General Concrete	1G52 ‡	Footings and pilecap	0.55	750	30/35/40	2 - 5"	4500 psi	2.D.1
	3G52 ‡	Footings, pilecap, walls, cast-in-place manholes and catch basins, fence posts, signal bases, light pole foundations, erosion control structures, cast-in-place box culverts, culvert headwalls, open flumes, cast-in-place wall stems	0.45	750	30/35/40	2 - 5"	4500 psi	2.D.1
M Median Barrier	3M12	Slipform barrier, median barrier, non-bridge	0.42	750	30/35/40	½ - 1" #	4500 psi	2.D.1
	3M52	Barrier, median barrier, non-bridge	0.45	750	30/35/40	2 - 5"	4500 psi	2.D.1
P Piling	1P62 ‡	Piling, spread footing leveling pad	0.68	750	30/35/40	3 - 6"	3000 psi	2.D.1
R Pavement Rehabilitation	3R52 ‡	CPR - Full depth concrete repairs, concrete base	0.45	750	30/35/40	2 - 5"	4000 psi	2.D.3
S Bridge Superstructure	3S12	Slipform bridge barrier, parapets, end post	0.42	750	30/35/40	½ - 1" #	4000 psi	2.D.2
	3S52	Bridge median barrier, raised median, pilaster, curb, sidewalk, approach panel, formed bridge barrier, parapet, end post, collar	0.45	750	30/35/40	2 - 5"	4000 psi	2.D.2
X Miscellaneous Bridge	1X62	Cofferdam seals, rock sockets, drilled shafts	0.45	750	30/35/40	3 - 6"	5000 psi	2.D.1
	3X62	Drilled shafts above frost line	0.45	750	30/35/40	3 - 6"	5000 psi	2.D.1
Y Bridge Deck §	3Y42-M 3Y42-S	Bridge decks, integral abutment diaphragms, pier continuity diaphragms, expansion joint replacement mix	0.45	750	30/35/40	2 - 4"	4000 psi	2.D.2
	3Y47 **	Deck patching mix	0.45	750	30/35/40	2 - 4"	4000 psi	2.D.2

* If the intended use is not included elsewhere in the Specification or Special Provisions, use mix 3G52, unless otherwise directed by the Engineer.
‖ Identify specific color used on the certificate of compliance. Colored concrete is only allowed when specified in the plans or the Contract.
† The minimum water/cement (w/c) ratio is 0.30.
‡ The Contractor may choose to use the Coarse Aggregate Designation "1" for the 4th digit in accordance with Table 2461-3.
# Adjust slump in accordance with 2461.3.G.7.a for slipform concrete placement.
§ The "-S" indicates a bridge deck with a structural slab and "-M" indicates a monolithic bridge deck.
** Mix 3Y47 requires the use of Coarse Aggregate Designation "7" or "3" for the 4th digit in accordance with Table 2461-3.

F.2.b(2) High-Early Concrete Mix Design Requirements

The Department defines High-Early (HE) concrete as concrete designed to achieve the minimum strength of 3000 psi for opening at 48 hours. Unless otherwise included in the plans, all HE concrete requires approval of the Engineer prior to incorporation into the work.

The Engineer will allow one of the following methods to determine minimum time to opening:
(A) Field control cylinders in accordance with 2461.3.G.5.c, "Field Control Strength Cylinders."
(B) Maturity method in accordance with 2461.3.G.6, "Estimating Concrete Strength by the Maturity Method."

The Department defines the concrete mix design requirements for High-Early concrete in accordance with Table 2461-7.

Table 2461-7
High-Early (HE) Concrete Requirements
(Not applicable to Bridge Superstructure or Mass Concrete)

Mix Number	Concrete Grades Allowed	Minimum Time to Opening	Maximum w/c ratio	Maximum Cementitious Content (lbs/ yd^3) *	Slump Range	Minimum Strength to Opening	Minimum 28-day Compressive Strength, f'c	3137 Spec.
3HE32	F	48 hrs	0.42	750	1 – 3" ‖	3000 psi	4500 psi	2.D.1
3HE52	B, F, G	48 hrs	0.42	750	2 – 5"	3000 psi	4500 psi	2.D.1
3YHE52	Y (Repairs Only)	48 hrs	0.42	750	2 – 5"	3000 psi	4000 psi	2.D.2
3RHE52	R (Repairs Only)	48 hrs	0.42	750	2 – 5"	3000 psi	4000 psi	2.D.3

* Supplementary Cementitious Materials allowed.
‖ Adjust slump in accordance with 2461.3.G.7.a,"Concrete Placed by the Slip-form Method."

F.2.b(3) Project Specific Mix Design Requirements

Submit project specific contractor designed mixes on the *Project Specific Mix Design Submittal* forms in accordance with Table 2461-8 and the Contract.

Table 2461-8
Project Specific Contractor Designed Mixes

Concrete Grade	Intended Use	Specification	3137 Spec.
A	Concrete Pavement	2301	2.D.3
M, W and Y	Precast Concrete	2462	Varies
HPC	High Performance Concrete	Special Provision 2401	2.D.2
MC	Mass Concrete	Special Provision 2401	Varies
CLSM	Cellular Concrete Grout	2519	None

F.3 Submittal Requirements

At least 21 calendar days before initial placement of the concrete, submit the appropriate *General Concrete Mix Design Submittal* form to the Concrete Engineer for approval. The Contractor Mix Design Forms are available from the MnDOT Concrete Engineering Website.

Design the concrete mix to an absolute volume of 27.00 – 27.27 cu. ft.

The Concrete Engineer will:
(1) Provide specific gravity and absorption data using oven dry (OD) weights for mix design calculations.
(2) Review the mix design submittal and approve the materials and mix design for compliance with the Specifications.

Table 2461-8 defines the mix design submittal requirements for Level 1 and Level 2 Mixes.

Table 2461-9
Mix Design Submittal Requirements

	SCM Substitution Limits	Fine Aggregate Limit	Gradation Requirements	Preliminary Test Data Requirements	Submittal Package
Level 1 Mixes *	Fly Ash: 0 – 15% Slag: 0 – 35%	40 – 45% of total aggregate by volume ‖	3126 and 3137	None	General Concrete Mix Design
Level 2 Mixes	Fly Ash: > 15% Ternary: Any	None	Use Either: • 3126 and 3137 • Job Mix Formula (JMF)	2461.2.F.3.a	Use Either: • General Concrete Mix Design • General Concrete Mix Design (JMF)

* High Early concrete in accordance with Table 2461-7 is defined as a Level 1 Mix.
‖ Fne aggregate limit does not apply to exposed aggregate concrete mixes.

F.3.a Preliminary Test Data Requirements for Level 2 Mixes

For Level 2 Mixes, submit the proposed Mix Design Proportions on the *General Concrete Mix Design Submittal* based upon either a suitable experience record or conventional trial mixtures not to exceed the limits specified in Table 2461-6 or 2461-7.

F.3.a(1) Suitable Experience Record

A suitable experience record consists of at least 30 consecutive tests, or two groups of consecutive tests totaling at least 30 tests, within the previous 18 months. If the Contractor does not have 30 tests, the Concrete Engineer will consider a minimum of 10 test results representing a time period of at least 45 days.

The Concrete Engineer considers a suitable experience record to have the following characteristics as compared to the proposed mix:

(A) An f'c no greater than 1000 psi above the required 28-day compressive strength,
(B) Same type or grade of cementitious materials,
(C) Same class of coarse aggregate,
(D) Aggregate weights within 10% of the proposed,
(E) Water/Cement ratio no greater than the maximum allowed,
(F) Cementitious or SCM material weights within 5% of proposed, and
(G) Batching conditions and testing procedures similar to those expected for the proposed work.

Submit all test results on the *Strength Test Data* sheet as part of the *General Concrete Mix Design Submittal*.

The Concrete Engineer reserves the right to request batching data representing the suitable experience record submittal.

F.3.a(2) Conventional Trial Mixtures

If the Contractor does not have a suitable experience record as required in 2461.2.F.3.a(1), "Suitable Experience Record" above, establish concrete proportions from trial mixtures, utilizing an AASHTO accredited laboratory in accordance with the following:

(A) Use proportions and consistencies required for proposed work at the w/c ratios or cementitious materials content that will produce a strength meeting or exceeding the required 28-day compressive strength *(f'c)* in accordance with Table 2461-6 or 2461-7;
(B) Design trial mixtures to produce slump within allowable slump range;
(C) For air-entrained concrete, design trial mixtures to produce air content within ± 0.5 percent of target air content;
(D) For each w/c ratio or cementitious materials content, make and cure at least three test cylinders for 28-day breaks in accordance with ASTM C 192. For HE concrete mixes, in addition to the 28-day cylinders, make a set of three test cylinders for 48-hour breaks in accordance with ASTM C 192.

Submit all test results for the trial mixtures, certified by the AASHTO accredited laboratory, in addition to the *General Concrete Mix Design Submittal*.

F.3.b Determining the Required Average Strength

Based upon the following information select the Mix Design Proportions required to produce f'cr.

Using the *Test Data* spreadsheet, determine the following:

(1) The Standard Deviation (S), and
(2) The Required Average Strength (f'cr) in accordance with Table 2461-10.

Table 2461-10
Required Average Strength (f'cr) Equations*

	Required Average Strength
f'c ≤ 5000 psi*	f'cr = f'c + 1.34S OR f'cr = f'c + 2.33S – 500
f'c > 5000 psi	f'cr = 0.90f'c + 2.33S

*When f'c ≤ 5000 psi, f'cr is the larger value computed from the equations.

F.4 Contractor Mix Design Adjustments

The Department will allow mix design adjustments based upon the criteria as defined in Table 2461-11:

Table 2461-11
Mix Design Adjustments Requirements

	Type of Change or Adjustment	Mix Design Resubmittal Requirements
Level 1 Mixes	• Cementitious Sources • Admixture Sources • Admixture Dosage Rate	No resubmittal required
	• Aggregate Sources • Aggregate Proportions • Any cementitious or SCM proportion (≤ 15% max fly ash)	Resubmittal of Mix Design
	• Any cementitious or SCM proportion (> 15% max fly ash)	Resubmittal in accordance with 2461.2.F.3.a
Level 2 Mixes	• Admixture Dosage Rate • Cement or SCM sources	No resubmittal required
	• Aggregate Source, no change in Aggregate Class • ≤ 5% in any cementitious or SCM proportion* • ≤ 10% in Aggregate Proportions	Resubmittal of Mix Design
	• Aggregate source and Class of Coarse Aggregate • > 5% in any cementitious or SCM proportion • > 10% Aggregate Proportions • Admixture Sources	Resubmittal in accordance with 2461.2.F.3.a

* Only one (1) increase in cementitious or SCM allowed per mix design, next adjustment requires resubmittal in accordance with 2461.2.F.3.a, "Preliminary Test Data Requirements for Level 2 Mixes"

F.5 MnDOT Review for Continual Acceptance of Contractor Mix Designs

The MnDOT Concrete Engineering Unit will review all test results relating to each individual Contractor approved mix design. MnDOT will review the following test results:

(1) Plant and Field Test Results
(2) Compressive Strength at 28 days
(3) Monthly Aggregate Quality Testing

Provided the concrete met the requirements of the Contract, had satisfactory placement and performance, the Contractor will have that mix design available for use during the next calendar year.

G Blank

H Concrete Yield

The Department defines concrete yield as the ratio of the volume of mixed concrete, less accountable waste, to the planned volume of the work constructed. The Department will not assume responsibility for the yield from a given volume of mixed concrete.

2461.3 CONSTRUCTION REQUIREMENTS
A Batching Equipment

A.1 Mixer Requirements
Provide stationary mixers or truck mixers.

A.2 General Condition
Maintain mixers as necessary to detect changes in condition due to accumulations of hardened concrete or mortar and examine to detect wear of blades.

Replace or recondition pickup and throwover blades in mixers with a rated capacity less than 14 cu. ft showing a blade wear loss of greater than ½ in, and pickup and throwover blades in mixers of greater capacity, showing a blade wear loss of no greater than ¾ in from the original factory dimensions.

A.3 Manufacturer's Rating Plate
Provide mixers that include the manufacturer's rating plate, showing the following information:

(1) Serial number of the unit,
(2) Mixing speed of the drum or paddles, and
(3) Maximum capacity in terms of volume of mixed concrete.

A.4 Drum Speed for Stationary Mixers
Operate the drum speed in the mixer as specified by the manufacturer or as directed by the Engineer.

A.5 Auxiliary Equipment Requirements
Provide mixers equipped with the following:

(1) Timing device,
(2) Discharge locking device,
(3) Water measuring device that operates mechanically and automatically during each batching cycle, and
(4) A graduated adjustable indicator device to represent the volume of discharge in increments no greater than ¼ gal in full view.

A.6 Mixer Capacity
Do not exceed the manufacturer's rated capacity of the mixer when mixing a single batch of concrete.

Batch concrete in volumes the mixer can accommodate without spilling, leaking, or segregating during the charging, mixing, or discharging operations.

A.7 Mixing Time
The Department defines the mixing time as the time period beginning when the cement and aggregates enter the mixer drum and ending when the discharge begins.

Refer to the manufacturer's recommended minimum mixing time for single drum and dual drum mixers. In the absence of manufacturer's recommendation, the Engineer will designate the minimum mixing time. The minimum mixing time for any concrete batch is 60 s. The Contractor may reduce the manufacturer's recommended minimum mixing time or the Engineer designated mixing time if the Contractor obtains uniform mixing in accordance with 2461.3.E, "Mixing Requirements," and as approved by the Engineer, in conjunction with the Concrete Engineer.

If there is evidence of inadequately mixed concrete (unmixed or partially mixed materials) during concrete placement, the Engineer may direct an increase in the mixing time.

A.8 Turbine Type Mixers
Provide turbine type mixers meeting the applicable requirements for conventional type mixers in accordance with 2461.3.A.1 through 2461.3.A.7 and this subsection. Maintain the mixer drum in a cylindrical shape within ¾ in from the original factory dimensions at any point. Maintain the mixer discharge gate in a mortar tight condition in the closed position. Replace or recondition mixer paddles showing a wear loss greater than ½ in from the original factory dimensions.

Add the mixing water to the batch materials in a manner that distributes the water to the inner or central areas of the drum. Start the flow of water before introducing the solid batch materials into the mixer drum.

During mixing, operate the paddles at a speed between 20 revolutions and 30 revolutions per minute. After adding the batch materials to the drum, mix the concrete for an additional 60 s.

A.9 Horizontal Axial-Revolving Blade Type Mixers

Provide horizontal axial-revolving blade type mixers (single or multiple shaft) in accordance with the applicable requirements for conventional type mixers in accordance with 2461.3.A.1 through 2461.3.A.7 and this subsection.

Charge the water, aggregates, and cement in the sequence recommended by the Manufacturer. Test the concrete uniformity as directed by the Engineer. The Engineer will use concrete uniformity tests to determine the minimum mixing time.

B Transportation Units

B.1 General Requirements

Equip transportation units intended for both mixing and agitating with watertight revolving drums mounted and powered and fitted with properly designed mixing blades in accordance with 2461.3.A.1 through 2461.3.A.7. Provide units capable of combining all the ingredients into a homogeneous mixture and designed to provide two drum speeds, one for mixing and the other for agitating. Provide units capable of delivering the concrete without segregation or loss of any of the batch materials.

Equip the mixer drum with a working counting device to record the number of revolutions.

Equip dump trucks and agitator trucks with vibrators to aid in discharge, are mortar tight, capable of complete discharge of the concrete and in accordance with 2301.3.F, "Placing Concrete."

B.2 Capacity of Transportation Units

Refer to the truck mixer manufacturer's certification plate attached to the unit for the maximum capacity of the unit. If the unit will not satisfactorily mix the maximum volume shown, reduce the batch volume to allow proper mixing or discontinue use of the mixing unit as directed by the Engineer until the problem is corrected.

C Handling and Storing Materials

C.1 Batch Material Requirements

Do not change the source, kind or gradation of batch materials after the start of concrete production for the work unless otherwise approved by the Engineer. If the Engineer approves use of different material, completely exhaust the supply on hand before changing to the different material.

If delivering freshly washed aggregates to the batching plant, drain the aggregates for at least 12 h before using in the batching operation. If draining freshly washed aggregates at the site of the batching plant, completely separate the drained material from the undrained materials, and provide for the disposal of water that accumulates from the drainage of materials.

Provide smooth, firm, and well-drained stockpile sites cleared of vegetation and extraneous matter. Where the natural foundation is unsatisfactory, as determined by the Engineer, construct the stockpiles on suitable platforms. Construct suitable bulkheads or partitions to separate different kinds of aggregate, gradation, or water content.

Construct stockpiles by methods that hold segregation and degradation to a minimum. If the Engineer sees segregation or degradation, the Engineer may designate that pile as unacceptable for use.

Do not use aggregates used to construct runways for loading or hauling equipment in concrete batches.

Use of aggregates from the bottom 1 ft of a stockpile placed on an unprepared surface in concrete batches is allowed only under the Engineer's direct supervision and if the material meets all requirements of 3126, "Fine Aggregate for Portland Cement Concrete," and 3137, "Coarse Aggregate for Portland Cement Concrete."

Provide aggregates in accordance with the specified gradation requirements.

The Engineer will consider aggregates unacceptable if the variation in moisture content carried by any of the aggregates causes a marked variation in the consistency of successive batches of the mixed concrete, and will suspend operations until corrected.

C.2 Concrete Temperature Control

Produce concrete at temperatures from 50 °F to 90 °F and maintain temperatures until deposited in the work.

If necessary to maintain placement temperature, uniformly heat or cool the water, aggregates, or both, before introduction into the mixer. Control the temperature of the mixing water during heating or cooling.

Use aggregate at temperatures from 32 °F to 130 °F. Do not allow cementitious material to contact other batch material when the aggregate temperature exceeds 130 °F.

Do not heat the cement, add salt, or add chemical admixtures to the concrete mix to prevent freezing.

Use a heating system to heat batch materials as approved by the Engineer. Do not use steam jets to spot heat the material as the work progresses.

Do not place mixer heaters intended for heating the batch materials in the mixer drum.

D Batching Requirements

Calibrate weighing equipment in accordance with 1901, "Measurement of Quantities." Inspect and calibrate the scales in accordance with the Concrete Manual.

D.1 Batching by Weight

D.1.a Proportioning Methods

Proportion concrete batch materials by weight in a central plant or by volume as directed by the Engineer, in conjunction with the Concrete Engineer.

D.1.b Weighing Equipment and Tolerances

Weigh or measure concrete mixture ingredients using load cells or meters for ready-mix and paving concrete to within the targeted batch weight in accordance with the following:

(1) Water – 1 percent,
(2) Cement – 1 percent,
(3) Other cementitious materials – 3 percent,
(4) Aggregates – 2 percent, and
(5) Admixtures – 3 percent.

D.1.c Batching of Mixing Water

Separately measure each type of mixing water on scales or water metering devices containing the following:

(1) A discharge indicator capable of being set to within 1 gal of a predetermined quantity,
(2) A positive automatic shutoff valve, and
(3) An approved inspection seal on the scale or water metering device dating the time of the previous calibration and adjustment

An authorized service agency will calibrate the water meter every 6 months and make adjustments as necessary before use meeting the requirements of the weighing procedure in the Concrete Manual.

Check the water meter for accuracy at least once each month as the work progresses.

D.1.d Batching of Cementitious Materials

Weigh the cementitious material independently of the aggregates in separate compartments or on separate scales.

If the Contractor weighs the cement first and then separately records the weights of each individual cementitious material, the Contractor may weigh the cementitious materials cumulatively as approved by the Engineer, in conjunction with the Concrete Engineer.

D.1.e Batching of Aggregates

If the Contractor records each individual fraction weight of aggregates separately, the Contractor may weigh aggregates cumulatively as approved by the Engineer, in conjunction with the Concrete Engineer.

D.1.f Admixture Proportioning

If using two or more admixtures in a single concrete batch, add each admixture separately to prevent interaction of the different admixtures before mixing with other batch materials. Agitate admixtures to ensure homogeneous concentrations in accordance with the manufacturers recommendations.

Incorporate admixtures to the batch mix in liquid form. Maintain admixture solutions at a uniform concentration at all times. Use the solution concentration and proportions designated by the manufacturer.

If using a mechanical dispenser for proportioning Class I or Class II admixtures, provide a site gauge or meter. Have the admixture manufacturer check admixture dispensers yearly to determine accuracy and ensure unobstructed flow.

D.2 Batching by Volume

Proportion concrete for bridge deck overlays by volume or as required by the contract.

If the Contractor calibrates the mixer for the specific batch materials in use, the Contractor may proportion concrete on other items of work by volume as approved by the Engineer in writing.

The Engineer will approve all methods and equipment used in volumetric proportioning.

Determine all material proportions and calibration settings on the basis of 100 lb of cementitious material.

Provide and use only sacked cement in the original mill containers unless the Contractor calibrates the mixer for the specific materials in use. Do not use previously opened sacks.

E Mixing Requirements

The Engineer may check the water measuring equipment for accuracy before mixing operations begin and at any other time the Engineer considers necessary.

Mix concrete by one of the following methods:

(1) A central plant (stationary plant),
(2) Entirely or in part in truck mixers, or
(3) At the construction site.

Do not allow the mixing batch to merge or intermix with the subsequent dry batch during mixing.

Discharge water remaining in the drums before batching.

Mix concrete to provide a mixture that is homogeneous and uniform in color. The Engineer will reject concrete batches that show a marked variation in consistency or evidence of improper mixing as unacceptable work in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

After completely mixing the concrete, either in a central plant mixer or truck mixer, continuously agitate while in transit to the point of placement until the concrete is discharged from the unit, unless otherwise allowed by the Engineer, in conjunction with the Concrete Engineer.

If the mixing does not appear uniform, perform slump tests at the 15 percentage point and the 85 percentage points during unloading. If the results show a slump variation greater than 1½ in, stop work and correct the mixing unit.

Produce concrete in such quantity and at such a rate as proper placement and finishing will permit. Do not re-temper partially set concrete.

Do not hand mix concrete.

E.1 Mixing In Truck Mixer

Charge the materials into the truck mixer drum by introducing sufficient water before adding solid materials. Perform charging operations without losing materials.

Leave the truck mixer at the plant site for a minimum of 5 min or 50 revolutions during the mixing period. Transport the concrete at agitating speed to the point of placement.

F Certified Ready-Mix Concrete

Provide concrete produced by a certified ready-mix plant. Ensure the Producer performs quality control of concrete production under a certification program for ready-mix concrete plants.

Provide batches for a delivered load of concrete in sizes of at least 1 cu. yd.

The Engineer may reject ready-mix concrete delivered to the work site that does not meet the specified requirements for delivery time, consistency, quality, air content, or other properties, as unacceptable work in accordance with 1512, "Unacceptable and Unauthorized Work."

F.1 Certified Ready-Mix Plant Program

The Producer will perform Quality Control (QC) as part of the production process under the certification program for ready-mix concrete plants. QC is the process control of the operations related to gradation and moisture control of the aggregates at the ready-mix plant. Provide and maintain a QC program for ready-mix production, including mix design, process control inspection, sampling and testing, and adjustments in the process related to the production of concrete. The Engineer will perform Quality Assurance (QA) as part of the acceptance process. QA is the process of monitoring and evaluating various aspects of the Producer's responsibilities related to the sampling, testing and production of concrete.

F.1.a Plant Certification

Prior to the production of Department concrete each construction season, a Department Representative shall perform a thorough on-site inspection of the concrete plant with a MnDOT Certified Plant Level 1 or Level 2 Technician, representing the Producer.

In order to obtain certification, complete the following:

(1) Identify all persons responsible for testing and overseeing plant operations including their email and cell phone number on the MnDOT Form 2163, *Concrete Plant Contact Report*.

(2) The Producer will complete MnDOT Form 2163, *Concrete Plant Contact Report,* prior to the on-site inspection with the Department Representative.

(2.1) A MnDOT Certified Concrete Plant Level 1 or 2 Technician, representing the Producer, signs the *Concrete Plant Contact Report* certifying compliance with the Certified Ready Mix requirements and continual maintenance of the plant to assure that the plant can produce concrete meeting MnDOT Specifications.

(2.2) A MnDOT Certified Concrete Plant Level 1 or 2 Technician, representing the Department, signs the *Concrete Plant Contact Report* signifying that the plant complies with all requirements prior to concrete production.

(3) Include a site map showing stockpile locations identified with the MnDOT pit number.

(4) Provide cementitious and admixture samples.

(5) Provide a computerized batching system capable of meeting the requirements of 2461.3.F.2, "Certificate of Compliance."

(6) Provide continuous access on-site to the Concrete Manual available from MnDOT's website.

(7) Supply a working email address, including an active internet connection, at the certified ready-mix plant.

(8) Keep plant reports, charts, and supporting documentation on file at the plant site for 5 calendar years.

(9) Provide electronic scales for weighing all materials.

(10) Provide facilities in accordance with 1604, "Plant Inspection – Commercial Facility," for the use of the plant technician in performing tests.

F.1.b Maintaining Plant Certification

The Producer will maintain plant certification by:

(1) Displaying the current Contact Report and site map in plain sight at all times;

(2) Updating the Contact Report with any material or equipment changes and submitting to the Department;

(3) Sampling and testing the materials in accordance with this section and the requirements of the Schedule of Materials Control;

(4) Documenting the production and testing of the materials used in the certified ready-mix concrete in the QC Workbook;

(5) Making Producer Plant QC Workbook and QC charts available electronically at all times;

(6) Supplying the following information at the request of the Engineer:

(6.1) Approved mix design sheets,

(6.2) Agency cementitious and admixture test results,

(6.3) Agency verification gradation test results,

(6.4) Aggregate quality test results.

Any procedural changes that cause non-compliance with this program may result in de-certification of the plant and cessation of further production of Department concrete as determined by the Concrete Engineer in accordance with 2461.3.F.4.h, "Certified Ready-Mix Plant Decertification."

F.2 Certificate of Compliance

Provide a computerized Certificate of Compliance with each truckload of ready-mixed concrete at the time of delivery. The Department defines computerized to mean a document that records mix design quantities from load cells and meters.

If the computer that generates the Certificate of Compliance malfunctions, the Engineer may allow the Contractor to finish any pours in progress if the Producer issues a handwritten MnDOT Form 0042, *Certificate of Compliance* with each load. Do not allow the Producer to begin new pours without a working computerized Certificate of Compliance.

Provide a computerized Certificate of Compliance that includes all of the following information:

(1) Name of the ready-mix concrete plant,

(2) Name of the Contractor,

(3) Date,

(4) State Project Number (SP) or (SAP),

(5) Bridge Number (if applicable),

(6) Time concrete was batched,

(7) Truck number,

(8) Quantity of concrete in this load,
(9) Running total of each type of concrete, each day for each project,
(10) Type of concrete (MnDOT Mix Designation Number),
(11) Cementitious materials using MnDOT Standard Abbreviations,
(12) Admixtures using MnDOT Standard Abbreviations,
(13) Aggregate sources using 5 digit State Pit Numbers,
(14) Admixture quantity in fluid ounces per 100 lb of cementitious materials or ounces per cubic yard,
(15) Batch weights in columns in accordance with Table 2461-12:
  (15.1) Print in order a through k.
  (15.2) Use formula to calculate weights.
  (15.3) Head columns with Standard Labels.

Table 2461-12
Standard Certificate of Compliance Labels

	Formula Letter	Formula	Standard Label
a	Ingredients (aggregate, cementitious, water, admixture type)	—	Ingredient
b	Product Source (MnDOT Standard Abbreviation)	—	Source
c	Total Moisture Factor (in decimals to 3 places)	—	MCFac
d	Absorption Factor (in decimals to 3 places)	—	AbsFac
e	MnDOT mix design oven dry (OD) weights, *lb/cu. yd*	—	OD
f	Absorbed moisture in the aggregates, *lb/cu. yd*	(e × d)	Abs
g	Saturated surface dry (SSD) weights for aggregates, *lb/cu. yd*)	(e + f)	SSD
h	Free moisture, *lb/cu. yd*	(c - d) × e	Free Mst
i	Target weights for one cubic yard of concrete, *lb/cu. yd*	(g + h)	CY Targ
j	Target batch weights, *lb*	(cu. yd × i) [cu. m × i]	Target
k	Actual batch weights, *lb*	—	Actual

NOTE: Actual cubic yards batched may vary due to differences in air content, weight tolerances, specific gravities of aggregates, and other variables.

(16) Total Water (Batch Water + Free Moisture) in pounds,
(17) Water available to add [(Mix Design Water × Batch Size) – Total water] in gallons,
(18) Space to note the water adjustment information, including:
  (18.1) Water in gallons added to truck at plant (filled in by Producer, enter zero if no water is added),
  (18.2) Water in gallons added to truck at the jobsite (filled in by Producer or Engineer, enter zero if no water is added), and
  (18.3) Total actual water in pounds (Total Water from Certificate of Compliance plus any additions).
(19) The following information printed with enough room beside each item to allow the Engineer to record the test results:
  (19.1) Air content,
  (19.2) Air temperature,
  (19.3) Concrete temperature,
  (19.4) Slump,
  (19.5) Cylinder number,
  (19.6) Location or part of structure,
  (19.7) Time discharge, and
  (19.8) Signature of Inspector.
(20) Location for the Producer signature
(21) For colored concrete, final color

F.3 Definitions

The Department defines ready-mix concrete as one of the following:
(1) Central-mixed concrete proportioned and mixed in a stationary plant and hauled to the point of placement in revolving drum agitator trucks or a truck mixer, or
(2) Truck-mixed concrete proportioned in a stationary plant and fully mixed in truck mixers.

Table 2461-13 defines commonly used certified ready-mix terms.

Table 2461-13 Certified Ready-Mix Terminology	
Term	Definition
Mix design water	The maximum allowable water content for 1 cu. yd of concrete.
Total moisture factor	Factor used to determine total amount of water carried by a given wet aggregate.
Absorption factor	Factor used to determine the water contained within the pores of the aggregate and is held within the particles by capillary force.
Free moisture	The water that is carried on the surface of the aggregate that becomes part of the total water.
Batch water	Water actually batched into the truck by the batcher. Batch water includes potable water and clarified water.
Total water	Batch water added to free moisture. Total water may also include the water used in diluting admixture solutions.
Temper water	Water added in mixer to adjust slump.
Total actual water	The water in the concrete mixture at the time of placement from any source other than the amount absorbed by the aggregate. It includes all batch water placed in the mixer, free moisture on the aggregate and any water added to the ready mix truck prior to placement.
Ready-Mix Producer or "Producer"	Party that is producing the concrete for the Contract. It is understood that the Ready-Mix Producer is the agent of the Contractor.
Water/Cement (w/c) Ratio	W/C ratio is defined as the ratio of the total water weight to the total cementitious weight, which includes cement and supplementary cementitious materials.

F.4 Contractor Quality Control (QC)

The Producer's responsibilities include the following:

(1) Maintain all plant and laboratory equipment within allowable tolerances as set forth in the MnDOT Specifications.
(2) Provide qualified personnel when producing certified ready-mix concrete.
(3) Spot check the actual batching of concrete to assure desired batch weights and tolerances comply.
(4) Check the bins and piles for segregation, contamination, or interblending of the aggregates.
(5) Check accuracy of scales and verify scale calibrations are up-to-date.
(6) Check that mix trucks are clean, blades are not worn, and revolution counters are working properly.
(7) Take cementitious and admixtures samples per Schedule of Materials Control.
(8) Document the following samples in the appropriate Sampling Log:
    (8.1) Cementitious Materials
    (8.2) Admixtures
    (8.3) Verification Gradations
    (8.4) Coarse Aggregate Quality

F.4.a Personnel

Provide a competent MnDOT Certified Concrete Plant Level 2 Technician who is responsible for all certified ready-mix plant operations and QC testing. The MnDOT Certified Concrete Plant Level 2 Technician is required to remain on-site during concrete production or have cellular phone availability.

Provide a MnDOT Concrete Plant Level 1 or Plant Level 2 Technician to perform all testing and quality control requirements of 2461.

F.4.b Sampling and Testing

Take all samples randomly in accordance with ASTM D 3665, Section 5, at a rate defined in accordance with the Schedule of Materials Control. Perform all sampling and testing in accordance with the Concrete Manual. The Engineer may oversee the QC sampling and testing process.

Perform QC gradation and moisture testing at the certified ready-mix plant site. Use mechanical shakers for sieve analysis. Determine the moisture content using the oven-dry method in all fractions of the aggregate.

Provide equipment and perform calibrations meeting the requirements of the following:

(1) AASHTO T 27, "Sieve Analysis of Fine and Coarse Aggregates,"
(2) AASHTO T 255, "Total Moisture Content of Aggregate by Drying,"
(3) AASHTO M 92, "Wire-cloth Sieves for Testing Purpose," and
(4) AASHTO M 231, "Weighing Devices Used in the Testing of Materials."

F.4.c QC Gradations

Complete the *Concrete Aggregate Worksheet* for each aggregate size and source:

(1.1) QC gradations;
(1.2) Verification Companion Gradations; The Engineer will not allow a Verification Companion Gradation as a substitute for a QC Gradation.

Identify QC companion samples with the following information:

(2.1) Date,
(2.2) Test number,
(2.3) Time,
(2.4) Type of material,
(2.5) Plant, and
(2.6) Sampling location.

F.4.d Aggregate Gradation QC Charts

Complete the *MnDOT Aggregate Gradation Control Charts* for each aggregate size and aggregate source:

(1) Record Producer QC gradation and Department Verification Companion gradation results. These results are included in the moving average calculation.
(2) Record Department Verification Gradation results. These results are not included in the moving average calculation.

F.4.e Moisture Content

Complete the *Batching Report* for each aggregate size and source.

F.4.f Plant QC Workbook

Complete the *Concrete Ready-Mix Plant QC Workbook* which includes all of the following documents:

(1) Diary
(2) Batching Report
(3) Concrete Aggregate Worksheet
(4) Weekly Concrete Aggregate Report
(5) JMF Concrete Aggregate Worksheet
(6) JMF Weekly Concrete Aggregate Report

The Producer will electronically submit the *QC Workbook* to the Engineer by the Tuesday immediately following the previous week's production.

F.4.g Signing the Certificate of Compliance

The Producer's MnDOT Certified Plant Level 1 or Level 2 technician will:

(1) Review the first Certificate of Compliance for each mix type, each day, for accuracy; and
(2) Legibly hand sign the Certificate of Compliance at a location designated for Producer signature signifying agreement to the terms of this program and to certify that the materials comply with the requirements of the Contract; and
(3) Write their MnDOT Technical Certification Number next to their signature.

F.4.h Certified Ready-Mix Plant Decertification

The Concrete Engineer, with coordination from the Engineer, may decertify the plant and halt production of concrete under any of the following conditions:

(1) Unauthorized procedural, material, or equipment changes made after the completion of the Concrete Plant Contact Report,
(2) Failure to meet the required testing rates,
(3) Failure to complete required documents,
(4) Disregards any of the requirements of this section, and
(5) Falsification of test records or certificates of compliance.

F.5 Quality Assurance (QA)

The Engineer's responsibilities include the following:

(1) Confirm the Producer's QC Workbook and Aggregate Gradation Control Charts are accurate and up-to-date;
(2) Check Certificate of Compliance for completeness and accuracy;
(3) Spot check the actual batching of concrete to verify batch weights and tolerances;
(4) Check the bins and stockpiles for segregation, contamination, and interblending of the aggregates;
(5) Obtain Aggregate Quality samples per Schedule of Materials Control;

(6) Observe Producer's Certified Technician obtain aggregate samples and run gradation and moisture tests when possible;
(7) Verify cementitious, and admixtures are certified and approved;
(8) Collect cementitious and admixtures samples per the Schedule of Material Control;
(9) Provide the following test results to the Producer:
  (9.1) Cementitious Materials
  (9.2) Admixtures
  (9.3) Verification Gradations
  (9.4) Coarse Aggregate Quality

F.5.a Personnel

The Department will utilize technicians with certification at least meeting MnDOT Concrete Plant Level 1 to perform all of the duties of 2461.3.F.5, "Quality Assurance (QA)."

F.5.b Verification Gradations

The Engineer will:
(1) Obtain Verification gradation samples per Schedule of Materials Control.
(2) Record the Verification gradation results on the MnDOT Form 24143, *Weekly Certified Ready-Mix Plant Report* or *Concrete Ready-Mix Plant QA Workbook*.
(3) Provide Verification gradation results to Producer in a timely manner, so they can enter into *Producer's QC Workbook*.
(3) Compare results with Verification Companion sample run at the plant for compliance with lab/field tolerance in accordance with Table 2461-16.

F.5.c Diary

The Engineer will provide plant diaries in accordance with the Concrete Manual.

F.5.d Batch Weight Verification

Each time the Engineer obtains a verification gradation, the Engineer will observe the actual water batched in a single load of concrete in accordance with the following:
(1) Watching the ready-mix truck reverse the drum after washing,
(2) Verifying use of the current moisture test,
(3) Verifying that any additional water added to adjust the slump is recorded, and
(4) Validating water weights on the load batched and comparing the total water with the design water.

The Engineer will document the actual water batched on MnDOT Form 24143, *Weekly Certified Ready-Mix Plant Report* or *Concrete Ready-Mix Plant QA Workbook*.

F.5.e QA Workbook

In lieu of completing a diary and the MnDOT Form 24143, *Weekly Certified Ready-Mix Plant Report*, the Engineer has the option of using the *Concrete Ready-Mix Plant QA Workbook*.

F.5.f Non-compliance with Certified Ready-Mix Plant Program

If the Engineer observes the Producer not complying with the requirements of the Certified Ready-Mix Plant Program, the Engineer may perform any or all of the following:
(1) Notify the Producer of observed deficiencies promptly, both verbally and in writing, and provide a time deadline to correct the non-compliance.
(2) Stop production until the Contractor takes corrective action.
(3) Order the Contractor to remove the non-competent person in accordance with 1802, "Qualification of Workers."

F.6 Acceptance of Concrete Materials

Only place concrete meeting the materials requirements in the work. If the Contractor places concrete not meeting the materials requirements into the work, the Engineer will not accept non-conforming concrete at the contract unit price.

F.6.a Aggregate Gradation (Does not apply to Job Mix Formulas)

The Engineer will base material acceptance on individual and moving average test results in accordance with Table 2461-14:

Table 2461-14 Acceptance Criteria for Aggregate Gradations		
	Contractor Action	
	Within Gradation Limits of MnDOT 3126 or 3137	**Outside of Gradation Limits in MnDOT 3126 or 3137**
Individual gradation test	Continue testing as required	(1) Immediately take second gradation (a) If second gradation passes, resume testing as required (b) If second gradation fails, stop production and contact Engineer (2) Resume production when corrective action results in a passing gradation and continue testing as required ‖
Moving average of 4 consecutive tests*	Continue testing as required	(1) Stop production and contact Engineer (2) Determine the cause of continual borderline or failing material (3) Resume production when corrective action results in a passing gradation (4) Increase gradation testing at a rate of 1 per 100 cubic yards until the moving average is within the gradation limits
	* If any aggregate size or source does not establish a moving average of 4 consecutive tests, use the average of all tests taken to determine acceptance. ‖The Engineer may increase the testing rates if gradation issues persist.	

(1) If the gradation tests on split samples from quality control or verification samples result in a variation between the Producer and the Engineer greater than that set forth in Table 2461-16, the Engineer will substitute QA and/or Verification test results into the moving average calculation to determine acceptance.

(2) If Producer test results are consistently coarser or finer than Engineer test results, the Engineer will review in accordance with 1503, "Conformity with Contract Documents."

(3) The Engineer will determine the monetary reduction due to the moving average gradation failure.

(3.1) Calculate the quantity of non-complying concrete placed, beginning with the first individual gradation test within the moving average failure and ending with the first passing individual gradation test after the moving average failure.

(3.2) Based on the total quantity of non-compliant concrete placed, the Engineer will apply the monetary reduction outlined in Table 2461-15.

(3.3) If a moving average failure occurs on multiple sieves, the Engineer will only reduce the price based on a single monetary deduction.

Table 2461-15 Moving Average Gradation of Specification Sieves	
Total Concrete Quantity Cubic Yards	**Lump Sum Monetary Reduction**
0 to 8	$125.00
> 8 to 15	$250.00
> 15 to 20	$375.00
> 20	$500.00 or $5.00 per cubic yard, whichever is greater

F.6.b Lab Field Tolerance

If the gradation tests on split samples from quality control or verification samples result in a variation between the Producer and the Engineer greater than that set forth in Table 2461-16, the parties shall follow the procedures for test result dispute resolution available from the MnDOT Laboratory Manual.

Table 2461-16 Allowable Variations on Percent Passing Sieves	
Sieve Size	**Allowed Percentage**
2 in – ⅜ in	± 6
No. 4 – No. 30	± 4
No. 50	± 3
No. 100	± 2
No. 200	± 0.6

F.6.c Coarse Aggregate Quality

The Engineer, in conjunction with the Concrete Engineer, will determine adjusted contract unit prices for coarse aggregate quality failures in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

F.6.d Cementitious Materials

The Engineer, in conjunction with the Concrete Engineer, will determine adjusted contract unit prices for cementitious failures in accordance with 1512, "Unacceptable and Unauthorized Work."

F.6.e Admixtures

The Engineer, in conjunction with the Concrete Engineer, will determine adjusted contract unit prices for admixture failures in accordance with 1512, "Unacceptable and Unauthorized Work."

G Concrete Placement

Assume full responsibility for the acceptable production, placement, finishing, and curing of all concrete under the conditions prevailing, regardless of the restrictions imposed. Provide any artificial lighting, rain or cold weather protection necessary at no additional cost to the Department.

Place concrete after the Engineer inspects and approves the foundation preparations, forms and falsework erection, placement of reinforcement steel, materials, equipment condition, and cold weather protection.

Do not place concrete if portions of the base, subbase, or subgrade layer are frozen, or if the excessive moisture levels make the grade unstable. Maintain the surface temperature above freezing for forms, steel, and adjacent concrete that will come in contact with the poured concrete before concrete placement.

Protect the concrete from freezing.

Protect the concrete against damage from construction operations or traffic.

The Engineer will evaluate any defects in concrete or concrete surfaces resulting from weather conditions, inadequate lighting, or other causes in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work."

G.1 Notice of Inspection

Notify the Engineer at least 24 h before beginning concrete production to allow the Engineer time to provide inspection forces needed for the work and to approve preparations for concrete placement. If the Contractor fails to provide 24 h notice, the Engineer may delay concrete placement and will consider any concrete incorporated into the work as unauthorized in accordance with 1512.2, "Unauthorized Work." The Engineer will consider any delays to the Contract resulting from unauthorized work as non-excusable in accordance with 1806.2.C, "Non-Excusable Delays."

If the producer needs to change plants during placement, notify the Engineer and obtain approval before changing the plant.

G.2 Placement Temperatures

Maintain concrete temperature from 50 °F to 90 °F until placement.

Unless Engineer approved cold weather protection plans are in –place, do not place concrete when the air temperature is either of the following at the point of placement:

(1) Below 36 °F, or
(2) The National Weather Service predicts the temperature to fall below 36 °F within the following 24 h period.

G.3 Delivery Requirements

Place concrete into the work in accordance with the following:

(1) Type 1 Concrete—within 90 min of batching, and
(2) Type 3 Concrete—within 90 min of batching when all admixtures are added at the plant at the manufacturer's recommended dosage rates listed on the Approved Products list. If the haul time does not facilitate mixing and placing the concrete within 90 min, test the concrete in accordance with 2461.3.G.3.a, "Delivery Time Beyond 90 Minutes."

The Contractor may transport Type 3 concrete in non-agitating equipment if the concrete is discharged within 45 min of batching.

Batch time starts when the batch plant or the transit mix truck adds the cement to the other batch materials.

G.3.a Delivery Time Beyond 90 Minutes

If the haul time does not facilitate mixing and placing the concrete within 90 min, perform the following procedures for pre-qualifying a concrete mix to extend the delivery time to 120 min. Extending the delivery time beyond 120 min will require additional testing at 30-minute intervals up to the maximum desired delivery time as directed by the Concrete Engineer.

(1) Provide a contractor mix design in accordance with 2461.2.F.b, "Contractor Designed Concrete Mixes," for each combination of materials;

(2) Laboratory trial batching on the proposed mix includes the following testing requirements:

- (2.1) Perform all laboratory trial batching at an AASHTO accredited laboratory;
- (2.2) Perform all plastic concrete testing after adding all admixtures to the concrete mixture;
- (2.3) Perform slump, air content, unit weight, and temperature testing immediately after batching, at 90 min, and at 120 min;
- (2.4) Fabricate concrete cylinders for compressive strength at 90 min and at 120 min (sets of 3) and cylinders for hardened air content testing at 90 min and at 120 min (sets of 5);
- (2.5) Test the cylinders for compressive strength at 28 days;
- (2.6) Determine the hardened air content (ASTM C457) at a minimum of 7 days. The Contractor is required to test 2 samples representing 90 min and 2 samples representing 120 min and provide MnDOT with the other 6 samples for testing at their discretion. Retain any hardened concrete test specimens for a minimum of 90 days for MnDOT to examine at their discretion;
- (2.7) Ensure the admixture manufacturer's technical representative is present during the trial batching;
- (2.8) Contact the MnDOT Concrete Engineering Unit a minimum of two (2) days before mixing. This same two (2) day notification is required before any physical testing on hardened concrete samples; and
- (2.9) Once accepted by the Concrete Engineer, the Department will consider the laboratory trial batching acceptable for use for five (5) years; unless they determine the material sources have changed significantly since the initial laboratory testing and acceptance. The Engineer will require field trial batching on all projects.

(3) Field trial batching on the proposed mix for each specific project shall include batching in the presence of the Engineer and the following:

- (3.1) Provide a QC Plan for extending the delivery time beyond 90 min;
- (3.2) Mix and transport the concrete using the same materials used in the laboratory trial batching;
- (3.3) Batch a minimum 5 cubic yards of concrete utilizing the same methods intended for use when supplying concrete placed into the permanent work;
- (3.4) Maintain the ready mix truck in transit; by either driving around the yard or on the roadway; and maintain the drum speed at 5 to 7 revolutions per minute for the entire 120 min;
- (3.5) Perform all plastic concrete testing after adding admixtures to the concrete mixture;
- (3.6) Perform slump, air content, unit weight, and temperature testing at 90 min and 120 min;
- (3.7) Fabricate concrete cylinders for compressive strength at 90 min and 120 min (sets of 3) and cylinders for hardened air content testing at 90 min and 120 min (sets of 2);
- (3.8) Test the cylinders for compressive strength at a minimum of seven (7) days;
- (3.9) Determine the hardened air content (ASTM C457) at a minimum of seven (7) days. The Contractor is required to test one (1) sample representing 90 min and one (1) sample representing 120 min and provide MnDOT with the other two (2) samples for testing at their discretion. Retain any hardened concrete test specimens for a minimum of 90 days for MnDOT to examine at their discretion;
- (3.10) Incorporate the trial batch concrete into other work with the approval of the Engineer; and
- (3.11) The Contractor must demonstrate to the Engineer the ability to properly mix, control, and place the concrete.

(4) The Concrete Engineer will review the trial batch results and all related concrete testing for compliance with the QC Plan and the Contract. Final approval of the mixture is based on satisfactory field placement and performance.

G.4 Field Adjustments

Mix the load a minimum of 5 min or 50 revolutions at mixing speed after addition of admixture or additional mixing water.

G.4.a Water Adjustments

The Engineer will allow water adjustments in accordance with all of the following:

(1) Prior to discharging approximately 1 cubic yard of concrete,

(2) Water is available to add as stated on the Certificate of Compliance, and

(3) Concrete is within 60 min from the initial batch time stated on the Certificate of Compliance.

G.4.b Water Adjustments for Concrete Placed by the Slip-Form Method

The Engineer will allow water adjustments for all grades of concrete placed by the slip-form method, except Grade A paving concrete, in accordance with all of the following:

(1) If water is available to add as stated on the Certificate of Compliance, and

(2) Concrete is within 60 min from the initial batch time stated on the Certificate of Compliance.

G.4.c Admixture Adjustments

Approved admixture additions are allowed within 90 min from the initial batch time stated on the Certificate of Compliance. If the load of concrete has no available water to add, or the load is greater than 60 minutes old, the Engineer will allow one admixture adjustment diluted with up to 2 gallons of water.

G.4.d Consistency and Air Content Adjustments

The Engineer will test the concrete for compliance with 2461.3.G.7, "Consistency," and 2461.3.G.8, "Air Content," in accordance with the following:

(1) If the first test taken by the Engineer passes, the Engineer will continue verification testing in accordance with the Schedule of Materials Control.
(2) If the test taken by the Engineer fails, make adjustments and perform any quality control testing before the Engineer performs a final test. Acceptance or rejection of the truck is based on the Engineer's final test result.
(3) The Engineer will test up to two additional trucks in accordance with items (1) and (2) above, and
(4) If the concrete does not meet the specification after those three trucks, the Engineer will reduce their verification testing rate to once per truck for acceptance for the remainder of the pour.

For concrete mixes 3U17A and 3U18, allow mix to hydrate 5 min before slump test to assure all cement is saturated.

G.5 Test Methods and Specimens

Perform random sampling and testing in accordance with the Concrete Manual and determine testing rates meeting the requirements of the Schedule of Materials Control.

The Engineer performs random sampling and testing in accordance with the Concrete Manual, determines testing rates meeting the requirements of the Schedule of Materials Control.

Anyone fabricating concrete cylinders or beams is required to hold either a current ACI Field 1 Technician Certification or a MnDOT Field 1 Technician Certification.

Anyone performing concrete strength testing of cylinders is required to hold one of the following current certifications:
(1.1) ACI Strength Testing Technician Certification,
(1.2) MnDOT Strength Testing Technician Certification, or
(1.3) WisDOT Strength Testing Technician Certification.

The Engineer will furnish molds based on the maximum size aggregate for the test specimens in accordance with the following:
(2.1) 4 in × 8 in cylinder molds,
(2.2) 6 in × 12 in cylinder molds for maximum aggregate sizes greater than 1¼ in, and
(2.3) 6 in × 6 in × 20 in beam molds; use other beam mold sizes as approved by the Engineer.

The Engineer will transport the cylinders in accordance with the following:
(3.1) A minimum of at least 16 hours after casting.
(3.2) A minimum of at least 12 hours after casting for high early strength (28-day) cylinders.
(3.3) With securely placed tight fitting plastic caps on plastic molds, or by other methods to prevent moisture loss.
(3.4) Protected from jarring, bouncing, and freezing.
(3.5) No greater than 4 hours, unless cylinders are maintained in the moistened condition at ambient temperature of 60 °F to 80 °F.

G.5.a Moist Curing Environments

At least 24 hours prior to concrete placement, provide moist curing environment(s) of adequate size and number, including all ancillary equipment and materials, necessary to maintain moist curing environment(s) in accordance with ASTM C31, 2031.3.C, "Special Requirements," and the following:

For each separate moist curing environment:
(1) Provide a calibrated waterproof digital temperature recording device that records the daily maximum and minimum ambient temperatures for the previous 7 days.
(2) Maintain the standard (28-day) strength cylinders or beams in an ambient temperature range from 60 °F to 80 °F during the initial and intermediate curing periods.

The Engineer will monitor the daily temperatures of the curing environments. Agency monitoring does not relieve the Contractor of the responsibility to maintain the water temperature as specified herein.

If the Contractor fails to comply with the requirements shown here-in, the Engineer may delay concrete placement and will consider any concrete incorporated into the work as unauthorized in accordance with 1512.2, "Unauthorized Work." The

Engineer will consider any delays to the Contract resulting from unauthorized work as non-excusable in accordance with 1806.2.C, "Non-Excusable Delays."

All costs related to providing and maintaining moist curing environments is considered incidental.

G.5.b Standard (28-day) Strength Cylinders

The Engineer will perform the following for standard strength cylinders:

(1.1) Cast cylinders (sets of 3) for testing at 28 days in accordance with the Schedule of Materials Control.

(1.2) Mark cylinders for identification of the represented unit or section of concrete in accordance with the following: (1.1, 1.2, 1.3/ 2.1, 2.2, 2.3/ 3.1, 3.2, etc.). In order to differentiate between portions of a project, prefixes and suffixes are allowed.

(1.3) Cure the cylinders meeting the requirements of the 2461.3.G.5.a, "Moist Curing Environments."

(1.4) Complete the MnDOT Concrete Cylinder Identification Card including the results for air content, slump (if required), concrete, and air temperature testing from the same load.

The Concrete Engineer defines the curing period as the following:

(2.1) **Initial curing period** as immediately after final finishing for a period of up to 48 hours. After the initial curing period, the Engineer will both transport and further cure the cylinders in the provided curing tanks for intermediate curing up to 7 days from the day of casting or deliver directly to the laboratory for final curing.

(2.2) **Intermediate Curing Period** as the time between specimen pickup from the initial curing site and delivery to the laboratory for final curing, not to exceed 7 days from the day of casting.

(2.3) **Final Curing Period** as the time when cylinders are cured in the laboratory within 7 days of casting.

G.5.c Field Control Strength Cylinders

The Engineer will use field control cylinders to determine when the sequence of construction operations is dependent upon the rate of concrete strength development. The Engineer will cast field control cylinders to determine when the concrete attains the required strength for all desired field control limitations.

The Engineer will perform the following for field control strength cylinders:

(1) Cast up to three (3) field control cylinders per structure. The Contractor is responsible for any additional field control cylinders.

(2) Mark field control cylinders for identification of the represented unit or section of concrete in accordance with 2461.3.G.5.a(2).

(3) Cure the cylinders in the same location and under the same conditions as the concrete structure or unit involved meeting the requirements of the Concrete Manual,

(3.1) For High-Early (HE) Concrete as defined in Table 2461-7, the Engineer will allow the Contractor to cure field control cylinders using insulated cylinder storage compartment. Provide insulated storage compartments and any equipment necessary to continually monitor temperatures of both the newly poured concrete structure and the insulated cylinder storage compartment. Maintain the insulated storage compartment at a temperature no greater than 5 °F above the newly poured concrete structures temperature. When the temperature exceeds 5 °F or the temperature monitoring system fails, the Engineer will not accept field control cylinder results.

(4) Complete the MnDOT Concrete Cylinder Identification Card including the results for air content, slump (if required), concrete, and air temperature testing from the same load.

During the Departments normal laboratory operating hours, the Engineer will perform compressive strength testing on the field control cylinders. If Project scheduling requires testing outside of the Departments' laboratories normal operating hours or the Department's nearest laboratory is greater than 30 miles from the project; Provide certified and calibrated hydraulic cylinder-testing machine within 30 miles of the project and at a location approved by the Engineer. Test the field control cylinders in the presence of the Engineer in accordance with ASTM C39.

The Engineer will allow the Contractor to submit a strength-maturity relationship curve for use in lieu of field control cylinders in accordance with 2461.3.G.6, "Estimating Concrete Strength by the Maturity Method."

G.5.d Strength Specimens for Concrete Paving

Use flexural beams to determine strength or provide cylinders as allowed by the contract or approved by the Engineer.

Cast standard beams or cylinders for testing at 28 days.

Cast a sufficient number of field control beams or cylinders to determine when the concrete attains the required strength for all desired control limitations.

Cure the standard beams or cylinders meeting the requirements of the Concrete Manual.

Cure the field control beams or cylinders in the same location and under the same conditions as the concrete structure or unit involved meeting the requirements of the Concrete Manual.

The Engineer will test the flexural beams and record the results on MnDOT Form 2162, *Concrete Test Beam Data*.

If using cylinders, the Engineer will submit cylinders and a completed identification card to the Department's Laboratory.

G.5.e Concrete Compressive Strength

The Concrete Engineer defines a single **strength test** as the average (28-day) strength of three (3) cylinders fabricated from a single sample of concrete and cured in accordance with the Concrete Manual.

If 1 of the set of 3 cylinders shows a strength variability of greater than 10% outside of the initial calculated three cylinder average strength, the Engineer will average the remaining two cylinders and report as the 28-day compressive strength.

If 2 or more of the set of 3 cylinders shows a strength variability greater than 10% outside of the initial calculated average strength, the Engineer will use all three cylinder results to calculate the 28-day compressive strength.

The Engineer will consider concrete acceptable in accordance with Table 2461-17 provided **both** the single strength test and the moving average of 3 consecutive strength tests are met for a required f'c.

Table 2461-17
Acceptance Criteria for Standard 28-day Cylinders

	Single Strength Tests	Moving average of 3 consecutive strength tests *
f'c ≤ 5000 psi	> (f'c – 500 psi)	≥ f'c
f'c > 5000 psi	> 0.90 * f'c	≥ f'c

* If a project does not establish a moving average of 3 consecutive strength tests, use the average of 2 strength tests to determine acceptance. If there is only a single strength test, contact the Concrete Engineer for recommendation.

G.5.f Non-Conforming Material

If the Contractor places concrete not meeting the strength requirements of 2461.3.G.5.e, "Concrete Compressive Strength" into the work, the Engineer may not accept nonconforming concrete at the contract unit price. The Engineer will evaluate non-conforming strength results in accordance with the following:

G.5.f(1) Single Strength Test ≤ 500 psi Below f'c

If any single strength test (3 cylinders) shows a strength ≤ 500 psi below f'c and is not deficient due to erroneous/invalid strength tests as defined in 2461.3.G.5.f(4), "Moving Average Below f'c", no additional investigation will occur and the Engineer will include the low strength test result in the moving average.

G.5.f(2) Single Strength Test > 500 psi Below f'c

If any single strength test (3 cylinders) shows a strength > 500 psi below f'c and is not deficient due to erroneous/invalid strength tests as defined in 2461.3.G.5.f(4), "Moving Average Below f'c", the Engineer, in conjunction with the Concrete Engineer, will investigate to determine if the concrete has attained the critical load-carrying capacity.

The investigation may consist of, but is not limited to reviewing the following:

(A) Sampling and testing plastic concrete
(B) Handling of cylinders
(C) Cylinder curing procedures
(D) Compressive strength testing procedures
(E) Certificate of Compliances
(F) Evaluation using Rebound Hammer (ASTM C803), Penetration Resistance (ASTM C805), or other method approved by the Concrete Engineer
(G) Review of the design calculations for the concrete in question

If it is determined that the concrete represented by the single strength test has attained the critical load carrying capacity, the Engineer will include the strength test in the moving average calculation.

If it is determined that the concrete has not attained the critical load carrying capacity, the Engineer will direct the Contractor to remove and replace concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work." The Contractor may dispute the remove and replace order within 7 days of written notification by the Engineer. If the Contractor disputes the order, follow the dispute resolution coring procedure in accordance with 2461.3.G.5.f(3), "Dispute Resolution Coring for Single Strength Test Failure."

G.5.f(3) Dispute Resolution Coring for Single Strength Test Failure

The Engineer and Contractor will mutually agree on an Independent Third Party to core and test the concrete in accordance with ASTM C42.

(A) The Engineer will identify a minimum of three (3) locations for the Independent Third Party to core.
(B) The Independent Third Party will take one (1) core at each location.
(C) The Independent Third Party will complete all coring within 14 days of notification of the low strength concrete.
(D) The Contractor is responsible for ensuring the core holes are repaired.

The Engineer, in conjunction with the Concrete Engineer, will review the core test results and evaluate in accordance with Table 2461-18, providing all other concrete tests meet requirements.

Table 2461-18
Evaluation of Core Test Results

Core (average of 3 cores) Test Results:	Engineer considers concrete:	Cost of Coring and Testing:	Resolution:
≥ 85% of f'c and No individual core is < 75% of f'c	Acceptable to remain in place	Agency	No monetary reduction for single strength test failure.
< 85% of f'c	Unacceptable	Contractor	Remove and replace concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work," as directed by the Engineer, in conjunction with the Concrete Engineer.

G.5.f(4) Moving Average Below f'c

If the moving average of three (3) consecutive strength tests < f'c, the Concrete Engineer will review the strength test results and determine if a new mix design is required in accordance with Table 2461-6 or Table 2461-7.

The Engineer will remove any strength test results from the moving average if the following occurs:
(A.1) After investigation the deficient concrete strength is found to be an erroneous/invalid strength test
(A.2) The suspect concrete was removed and replaced
(A.3) Dispute resolution coring identified the concrete acceptable to remain in place

Reasons for finding erroneous test results as determined by the Concrete Engineer:
(B.1) Cylinders kept in the field longer than 7 days,
(B.2) Improper handling/curing of the cylinders, and/or
(B.3) Improper testing of the cylinders

For the quantity of non-conforming concrete not meeting the moving average of three (3) consecutive strength tests, the Engineer will make determinations regarding the disposition, payment, or removal of the concrete in accordance with Tables 2461-19.

Table 2461-19
All Concrete Grades

Moving average of 3 consecutive strength tests	Monetary Reduction for Moving Average Failure *
> 93.0% of f'c	$20.00 per cubic yard or 10% of the Contractor-provided invoice for quantity represented by test that brought moving average into non-conformance
≥ 87.5% and ≤ 93.0% of f'c	$50.00 per cubic yard or 25% of the Contractor-provided invoice for quantity represented by test that brought moving average into non-conformance
< 87.5% of f'c	Remove and replace concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work," as directed by the Engineer. If the Engineer, in conjunction with the Concrete Engineer, determines the concrete can remain in place, the Engineer will adjust the concrete at a reduction of $100.00 per cubic yard or 50% of the Contractor-provided invoice for quantity represented by test that brought moving average into non-conformance.

G.6 Estimating Concrete Strength by the Maturity Method

The Engineer will allow the maturity method to determine development of concrete strength. Use of this method requires the establishment of a relationship between concrete strength and the computed maturity index (using the Nurse-Saul method) for a specific concrete mixture prior to construction. Use this method, in accordance with this specification and the Concrete Manual to estimate the in-place strength of the concrete.

G.6.a Development of Maturity-Strength Relationship

The Engineer will allow development of the maturity curve in either the laboratory or in the field, provided the precautions for field curing and testing are followed, as described in the MnDOT Concrete Manual. Test the concrete strength specimens for development of the maturity curve.

Determine the strength development criteria based on the type of concrete in accordance with the following:

(1) For concrete pavement: 2301.3.O, "Opening Pavement to Traffic,"
(2) For concrete pavement repairs: 2302.3.B.4, "Opening to Construction Equipment and Traffic,"
(3) For concrete structures: 2401.3.G, "Concrete Curing and Protection"
(4) For sidewalks, driveway entrances and curb and gutter, a minimum of 3000 psi is required.

Until an acceptable strength-maturity relationship is established, verify strength using concrete beams or cylinders.

G.6.a(1) Procedure

Estimate the in-place concrete strength using the maturity method as described in ASTM C1074, except as noted in this specification as follows:

(A) Fabricate 15 cylinders plus 2 additional cylinders to embed temperature sensors or 15 beams;
(B) The Nurse-Saul method of computing maturity;
(C) A datum temperature of -10 °C (14 °F);
(D) Maintain specimens at temperatures greater than 50 °F for the duration of the maturity curve development.

Test three (3) strength specimens at five different ages specified in Table 2461-20 for the type of concrete work.

Table 2461-20
Chronological Testing Ages of Strength Specimens

Type of Concrete	Testing Ages *
Concrete Pavement as defined in 2301	Determined by the Contractor ‖
Normal Strength Concrete as defined in 2461	1, 2, 3, 7 and 28 days
High-Early (HE) Concrete as defined in 2461	12 hours, 1, 2, 7 and 28 days
Ultra High-Early (UHE) Concrete as defined in 2302	3, 4 and 8 hours, 1 and 14 days

* The Contractor may adjust the testing ages if approved by the Engineer, in conjunction with the Concrete Engineer.
‖ Test at least two (2) sets of strength specimens before the anticipated opening strength.

G.6.a(2) Equipment

Provide the following equipment for determining the maturity:

(A) Maturity meter or temperature sensor and data logger with a secure means of collecting data that is unalterable, and conforms to the requirements in ASTM C1074.
(B) Beam or cylinder molds for development of the maturity curve and other concrete making and testing equipment.

G.6.b Estimating In-Place Strength Using Maturity

Place concrete maturity meters or temperature sensors within the concrete in accordance with Table 2461-21.

Table 2461-21 Maturity Meter or Temperature Sensor Placement and Frequency		
Maturity Application	**Placement**	**Frequency**
Concrete Paving	Embed at approximately mid-depth and approximately 18 (but no less than 12) inches from the edge of the pavement.	Place at least one for every 1,500 lineal feet of paving, including one in the last 50 feet of each day's paving.
Full Depth Concrete Pavement Repairs	Embed at approximately mid-depth and approximately 18 (but no less than 12) inches from the edge of the pavement.	Place at least two for each day of concrete placement with one at the end of the day.
Partial Depth Concrete Repairs	Embed at least 2 inches from the surface.	Place at least two for each day of concrete placement with one at the end of the day.
Sidewalk, Driveway Entrances, Curb and Gutter	Embed at approximately mid-depth and approximately 18 (but no less than 12) inches from the edge of the pavement.	Place at least two for each day of concrete placement with one at the end of the day.
Concrete Structures	Attach to the reinforcing steel near the edge of the exposed surface using a non-metallic fastener.	Place at least two for each concrete element.

The computed maturity results from each sensor will only apply to concrete placed under the following conditions:
(1) The same mix designation and the same project as the test location,
(2) Placed on the same day and on, before, or within 50 feet after placement of the sensor,
(3) Cured under conditions similar to those of the test location.

Record the temperature readings and calculate the maturity values on the *Maturity-Field Data* form.

G.6.c Verify Strength-Maturity Relationship

Perform a verification strength test to ensure the in-place concrete strength correlates with the maturity-strength relationship as follows:

(1) Notify the Engineer at least 24 hours in advance of the time and location of both the verification specimen's casting and strength testing.
(2) When the maturity curve is developed prior to the start of construction or in a laboratory, perform a verification strength test on the first day of concrete placement.
(3) Perform a verification strength test at least once every seven (7) calender days during normal plant production for concrete paving. For all other concrete, perform a verification strength test at least once every thirty (30) calendar days during normal plant production.
(4) If the plant has not supplied concrete to the project for a period of greater than thirty (30) calendar days, perform a verification strength test.
(5) Cast 3 cylinders plus one additional cylinder to embed the temperature sensor or 3 beams for each verification strength test.
(6) The Engineer will test the concrete strength specimens for verification of the maturity curve as close to the maturity value determined to represent the opening, loading or form removal strength criteria in accordance with the Concrete Manual.
(7) Record the results of verification test on the *Concrete Maturity-Strength Verification* form and submit an updated copy with the newest test result to the Engineer the day that the verification test is completed.
(8) The Engineer may direct additional verification testing as necessary.
(9) Submit electronic data from the maturity meters or temperature loggers in a comma-delimited (.txt or .csv) file format to the Engineer, which includes at least the project number, date and location of the meters or loggers.

The Engineer will review and interpret the verification strength test results and determine if the verification testing validates the maturity curve in accordance with Table 2461-22.

Table 2461-22 Interpreting Verification Strength Test Results		
If the actual verification strength test falls:	**Result**	**Action**
Within the 10% limits of the maturity curve	Maturity curve verified	Continue using the current maturity curve
> 10% higher than the maturity curve	The Engineer will not consider the maturity curve verified, but may consider acceptable for future use if verified.	Develop a new maturity curve at the discretion of the Contractor.
> 10% lower than the maturity curve	The relationship will no longer be acceptable and a second verification test is required, or the Contractor can develop a new maturity-curve, at their discretion.	1. Perform a second verification test. 2. If the second verification test does not fall within 10% of the maturity curve, develop a new maturity-strength relationship. 3. The Engineer will not allow the maturity method for that concrete mix until a new relationship is developed.

G.6.d Changes in Concrete Mixture

The Engineer may require development of a new maturity-strength relationship if any of the following changes occur:

(1) Change in mixture proportions greater than 5% by weight

(2) Increase in the water-cementitious materials ratio by more than 0.02

(3) Change in the source of any material in the approved mix design

If any of the changes in this subsection occur for a particular concrete mix, perform a verification test in accordance with 2461.3.G.6.c, "Verify Strength-Maturity Relationship."

G.6.e Maturity Meter Calibration

Calibrate maturity meters yearly to ensure proper operation and temperature sensing.

Verify proper operation of maturity sensor every 30 days during normal plant production in accordance with the Concrete Manual.

G.7 Consistency

The Engineer will test the concrete for consistency using the slump test during the progress of the work. The Engineer may reject concrete batches with consistencies outside of the slump range limits in Table 2461-5, Table 2461-6 and Table 2461-7.

If any test shows the slump outside of the slump range requirements, the Engineer will reject the concrete represented by that test. In order to bring the mixture back into the slump range requirements, the Engineer will allow adjustments to the concrete in accordance with 2461.3.G.3, "Delivery Requirements" and 2461.3.G.4, "Field Adjustments.

Adjust the slump not to exceed the slump range allowed to optimize both placement and finishing. Contact the Engineer if encountering unusual placement conditions that render the maximum slump unsuitable.

G.7.a Concrete Placed by the Slip-Form Method

Place concrete that does not slough and is adequately consolidated at a slump value that optimizes placement for the designated mixture and in accordance with 2461.3.G.4, "Field Adjustments."

G.7.b Non-Conforming Material

Only place concrete meeting the slump requirements in the work. If the Contractor places concrete not meeting the slump requirements into the work, the Engineer will not accept non-conforming concrete at the contract unit price.

For the quantity of non-conforming concrete not meeting the required slump, the Engineer will make determinations regarding the disposition, payment, or removal of the concrete in accordance with Tables 2461-23 and 2461-24.

Table 2461-23 All Concrete Grades > 1 in slump	
Outside of Slump Range	**Monetary Reduction**
Below slump range *	No deduction for materials placed as approved by the Engineer.
≤ 1½ in above slump range	$20.00 per cubic yard or 10% of the Contractor-provided invoice for quantity represented by the materials placed
> 1½ in above slump range	$50.00 per cubic yard or 25% of the Contractor-provided invoice for quantity represented by the materials placed
* The Engineer will not reduce contract unit price for low slump concrete placed with the slip-form method as approved by the Engineer.	

Table 2461-24 Low Slump Concrete From ½ in to 1 in	
Outside of Slump Range	**Monetary Reduction**
Below slump range *	No deduction for materials placed as approved by the Engineer
≤ ½ in above slump range	$20.00 per cubic yard or 10% of the Contractor-provided invoice for quantity represented by the materials placed
≥ ¾ in above slump range	$50.00 per cubic yard or 25% of the Contractor-provided invoice for quantity represented by the materials placed
* The Engineer will not reduce contract unit price for low slump concrete placed with the slip-form method as approved by the Engineer.	

G.8 Air Content

Maintain the air content of Type 3 general concrete at the specified target of 6.5 percent (+2.0 percent and −1.5 percent) of the measured volume of the plastic concrete in accordance with 1503, "Conformity with Contract Documents."

Measure the air content at the point of placement but before consolidation.

Make any adjustments immediately to maintain the desired air content.

G.8.a Non-Conforming Material

Only place Type 3 concrete meeting the air content requirements in the work. If the Contractor places Type 3 concrete not meeting the air content requirements into the work, the Engineer will not accept non-conforming concrete at the contract unit price.

For the quantity of non-conforming concrete not meeting the required air content, the Engineer will make determinations regarding the disposition, payment, or removal in accordance with Table 2461-25.

Table 2461-25 All Concrete (Target Air Content 6.5%)	
Air Content, %	**Monetary Reduction**
> 10.0	$50.00 per cubic yard or 25% of the Contractor-provided invoice for quantity represented by the materials placed
>8.5 – 10.0	$20.00 per cubic yard or 10% of the Contractor-provided invoice for quantity represented by the materials placed
5.0 – 8.5	The Engineer will pay 100 percent of the contract unit price for the concrete represented, for material placed as approved by the Engineer.
>4.0 – <5.0	$50.00 per cubic yard or 25% of the Contractor-provided invoice for quantity represented by the materials placed
>3.5 – ≤4.0	The Engineer, in conjunction with the Concrete Engineer will determine the concrete suitability for the intended use in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work." This may include testing on the hardened concrete as required by the Engineer, in conjunction with the Concrete Engineer.
≤ 3.5	Remove and replace concrete in accordance with 1503, "Conformity with Contract Documents," and 1512, "Unacceptable and Unauthorized Work," as directed by the Engineer. This may include testing on the hardened concrete as required by the Engineer, in conjunction with the Concrete Engineer. If the Engineer, in conjunction with the Concrete Engineer, determines the concrete can remain in place, the Engineer may not pay for the concrete and may require coating with an approved epoxy penetrant sealer from the Approved/Qualified Products List.

G.9 Allowable Testing Tolerances

Allowable tolerances are based on the results from two different testers and two different pieces of equipment from the same sample. Perform the test within the allowable tolerances in accordance with Table 2461-26.

Table 2461-26 Allowable Testing Tolerances	
Test	**Allowable Tolerance**
Air content, % volume of concrete	1.0 %
Average slump:	
< 4 in	1.0 in
4 in – 6 in	1.5 in
> 6 in	2.0 in
Unit weight, per cu. ft, calculated to an air-free basis	1.0 lb/cu. ft
Compressive strength 3,000 psi – 8,000 psi, average of 3 tests	500 psi

2472 METAL REINFORCEMENT

2472.1 DESCRIPTION

This work consists of providing and placing metal reinforcement of the types, shapes, and sizes as required by the contract.

2472.2 MATERIALS

A Reinforcement Bars.....3301

B Steel Fabric.....3303

C Spiral Reinforcement.....3305

2472.3 CONSTRUCTION REQUIREMENTS

A Bending

Bend bars to the shapes as shown on the plans. The Contractor may bend the bars cold. If hot bending a non-coated bar, do not heat bars to temperatures greater than 1,200° F and do not quench the bars.

Bar bending details shall conform to the American Concrete Institute 315, "Details & Detailing of Concrete Reinforcement," unless otherwise shown or noted in the plans. Ensure that the bar bend diameters are as shown "Recommended" in the American Concrete Institute 315.

Repair bond loss or coating damage after bending epoxy coated reinforcement bars in accordance with 3301, "Reinforcement Bars." Clean damaged areas to remove loose or deleterious material before patching. Remove rust by blast cleaning. The Engineer, in conjunction with the Materials Engineer, will not require the repair of hairline cracks with no bond loss or other damage. Perform repairs before oxidation appears.

B Storage and Protection

Do not store metal reinforcement in a manner that will cause, induce, or accelerate corrosion or contamination of the metal. Locate timbers (dunnage) on the ground to support the bundles and keep them free of contamination. Store materials at the project site to allow the Engineer to visually inspect and check the various types of reinforcement for conformance to the dimensions as shown on the plans. Store bars of the same type together. Identify reinforcement bars with tags bearing the identification symbols as shown on the plans.

Protect coated reinforcement bars before handling or shipping to prevent damage to the coating. Pad bundling bands and lift bundles using an OSHA-approved spreader bar, multiple supports, or platform bridge to prevent bar-to-bar abrasion from sags in the bar bundle. Do not drag or drop bars or bundles. Support bars or bundles in transit to prevent damage to the coating.

If the epoxy-coated reinforcing steel is incorporated into the Project and is exposed to the weather or stored exposed to the weather for more than 60 calendar days, cover the steel to protect the material from sunlight, salt-spray and weather exposure. Provide for air circulation around the covered steel to minimize condensation under the protective covering.

C Placing, Supporting, and Tying Bar Reinforcement

C.1 General Requirements

Before placing concrete in a unit, ensure the reinforcement bars meet the condition defined in the current CRSI manual titled *Placing Reinforcing Bars,* Chapter VII, "Unloading, Storing, and Handling Bars on the Job." Place the bars as specified in "Tolerances in Placement" section in Chapter X, "General Principles for Bar Placing, Splicing and Tying Reinforcing Bars."

Carefully place the beam seat/pedestal reinforcement to avoid interference with drilling holes for fixed bearing anchor rods. Provide a template demonstrating that the anchor rods have a 2 inch clear distance to all reinforcement for the entire embedment at all bearing anchor rod locations. Confirm the proper clearance to the reinforcement with the Engineer prior to placing the affected substructure concrete. Place the beam or girder in its final position prior to drilling or coring holes for the anchor rods. If reinforcement steel is encountered during the drilling or coring process, contact the Engineer, and the Engineer will determine how to proceed. Verify the depth of the holes in the presence of the Engineer prior to inserting the anchor rods.

Firmly support and securely tie reinforcement bars in their proper position. Tie all outermost intersections, and enough of the intermediate intersections, to ensure that no shifting or displacement of the bars will occur during subsequent operations. Bar supports are intended to support the steel reinforcement and normal construction loads; and are not intended to, and should not be used to, support runways for concrete buggies or similar loads. Use black, soft iron wire of at least 16 gauge for tying the reinforcement bars. Do not use welded ties. Do not place concrete before the Engineer inspects and approves the placement, support system, and ties for the reinforcement bars.

Provide supports with the following characteristics for reinforcement bars bearing on the falsework sheathing for exposed concrete surfaces:

(1) Stainless steel;
(2) Hot-dip galvanized, epoxy, vinyl, or plastic coated tips extending at least ½ inch above the sheathing; or
(3) Plastic.

The wire coating shall not chip, peel, crack, or distort under any job conditions and temperatures.

C.2 Special Requirements for Bridge Slabs

Support and tie reinforcement bars for bridge slabs in accordance with the General Requirements and the maximum spacing requirements specified in Table 2472-1. These spacing requirements define only the maximum permissible distances between ties or lines of support. Table 2472-1 does not relieve the Contractor of responsibility for providing additional supports or ties for holding and supporting bars firmly in their correct position.

For bridge slabs, use slab bolsters as the primary support for the bottom transverse reinforcement bars meeting the requirements of "Bar Support Specifications and Standard Nomenclature" in the *CRSI Manual of Standard Practice*. Place the bolsters on the falsework sheathing in continuous lines, parallel to the beams, girders, or centerline of the roadway at locations that will permit placement of supports for the top transverse reinforcement bars directly over the bolsters on the bottom transverse bars.

Use continuous lines of upper continuous high chairs with wire runners as the support system for the top transverse reinforcement bars. Place the high chairs to transfer load to the bottom bolsters without causing deflection in the bottom transverse bars. Use individual type high chairs only as supplemental support or for sections where the use of continuous type high chairs is not practical and the Engineer approves, in writing, the use of the individual type high chairs.

For all interior bays on beam span bridges, place slab bolsters and upper continuous high chairs within 6 inches of the edge of beam flanges.

Use tie wires to tie down the top mat of bridge slab reinforcing to the in-place beam stirrups or shear connectors at spacing no greater than 5 ft, as measured longitudinally along each beam.

If the support system specified in this section is not practical, the Contractor may propose an alternative support system for slab span bridges or other special designs. Provide working drawings showing the proposed support system to the Engineer. If approved by the Engineer in writing, the Contractor may use the proposed support system.

Table 2472-1
Maximum Spacing of Supports and Ties for Bridge Slabs

Bar Size Number	Maximum Spacing for Slab Bolsters and Continuous Type High Chairs, *ft*
3 and 4	3.00
5, 6, and 7	4.00

Support the bottom layer of longitudinal reinforcement bars for slab span bridges, cast-in-place concrete girders, beams, struts, and similar sections on beam bolsters or heavy beam bolsters commensurate with the mass to be supported. Do not use precast concrete block or brick supports on formed surfaces.

Use the upper beam bolsters or the upper heavy beam bolsters to support subsequent layers of longitudinal bottom reinforcement, except for bars that can be tied to vertical bars, unless otherwise approved by the Engineer.

After the completion of the placement and tying of the reinforcement bars for a section of bridge slab, and before ordering concrete delivery for that section, set the strike-off rails or guides to the correct elevation. Notify the Engineer when the section is ready for a final check. Operate the strike-off device over the entire section in the presence of the Engineer. Attach a filler strip, ¼ inch less in thickness than the minimum concrete cover requirement, to the bottom of the strike-off during this check to detect areas where the top reinforcement may encroach on the required clearance. Do not place concrete for a bridge slab before the Engineer inspects and approves the deck grades.

Tie the top mat of epoxy-coated reinforcement bars at every transverse bar intersection along each continuous row of longitudinal bars. Tie the bottom mat of reinforcement bars and non-continuous rows of top mat bars at least at every second transverse bar intersection. Stagger the ties for the bottom mat along adjacent rows of longitudinal bars. Use plastic or nylon-coated tie wires.

Use plastic bar supports or epoxy-coated wire bar supports with coating resistant to abrasion. Provide epoxy coating for bar supports at least 0.005 inch thick and in accordance with 3301, "Reinforcement Bars." Provide plastic coated tips or additional epoxy coating on the legs of the supports for wire bar supports that bear on falsework sheathing for exposed concrete surfaces. Ensure the additional material extends at least ½ inch above the sheathing, not including portions of the supports other than the legs. Use a grey-colored coating with a total coating thickness on the ½ inch portion, including the initial 0.005 inches of epoxy coating, of at least $^{3}/_{32}$ inch. Use incompressible and abrasion resistant plastic or epoxy material.

C.3 Special Requirements for Coated Bars

The Engineer will not require the Contractor to repair damage caused during shipment of coated bars or by the installation procedures if the damaged area is no greater than ¼ inch × ¼ inch and the sum of damaged areas in each 1 ft length of bar is no greater than 2 percent of the bar surface area. Repair damage greater than ¼ inch × ¼ inch as recommended by the manufacturer. The Engineer will reject bars with total damage greater than 2 percent of bar surface area. Remove rejected bars. Ensure the total bar surface area covered by patching material is no greater than 5 percent.

Do not flame cut coated reinforcing bar in any application.

If using an abrasive blade to cut epoxy-coated reinforcing bar and the cut ends are properly coated with a two-part epoxy patching material as recommended by the manufacturer of the epoxy coating, the Department will allow cutting of epoxy-coated bars.

Use a non-metallic vibrator head to consolidate the concrete around coated reinforcement bars and other components.

D Splicing Metal Reinforcement

Provide reinforcement in the lengths shown on the plans. Do not place splices unless otherwise shown on the plans or approved in writing by the Engineer. Place field splices at locations and with details as approved by the Engineer.

D.1 Lap Splices

Provide lap splices as shown on the plans. If not shown on the plans, provide bar reinforcement lap lengths per table 2472-2, "Length of Bar Splices."

Table 2472-2
Length of Bar Splices

U.S. Customary Bar Size	Diameter		Number of Diameters	Length of Splice, *inches*
	Fraction *inches*	Decimal *inches*		
3	$^{3}/_{8}$	0.375	36	14
4	$^{1}/_{2}$	0.500		18
5	$^{5}/_{8}$	0.625		23
6	$^{3}/_{4}$	0.750		27
7	$^{7}/_{8}$	0.875		32
8	1	1.000	40	40
9	$1\text{-}^{1}/_{8}$	1.128		45
10	$1\text{-}^{1}/_{4}$	1.270		51
11	$1\text{-}^{3}/_{8}$	1.410		56

Table 2472-2 Length of Bar Splices				
U.S. Customary Bar Size	Diameter		Number of Diameters	Length of Splice, *inches*
	Fraction *inches*	Decimal *inches*		
14	$1\text{-}^{3}/_{4}$	1.693	Must be pre-approved by the Engineer in writing	
18	$2\text{-}^{1}/_{4}$	2.257		

Lap wire mesh reinforcement at least the width of one full mesh plus 2 inches for transverse laps or one full mesh plus 2 inch plus two end overhangs for longitudinal laps.

D.2 Couplers for Reinforcement Bars

Provide reinforcement bar couplers at construction joints in the locations as shown on the plans and with the following characteristics:

(1) Epoxy-coated in accordance with 3301, "Reinforcement Bars,"
(2) Developing at least 125 percent of the yield strength of the reinforcement bar, and
(3) Having a fatigue design limit of at least 12 ksi when tested in accordance NCHRP Project 10-35.

Submit written coupler details, yield strength and fatigue test results, and the name of the manufacturer to the Engineer for written approval before installation. If assembling threaded couplers, insert the bar into the coupler to the full depth of the thread and torque the assembly as recommended by the manufacturer.

E Spiral Reinforcement

The Contractor may provide rigid or collapsible cages of spiral reinforcement for circular columns. Finish the ends of each column spiral with one and one-half turns of the reinforcement.

The Contractor may make the spiral cages rigid by tying the vertical column bars to the spiral wires at their intersections or by using epoxy-coated metal spacer strips. Provide enough tied intersections or use enough spacer strips to ensure a rigid noncollapsible cage with properly spaced loops when the cage is in its final position. Do not tack weld the reinforcement.

Provide full-length spiral reinforcement cages. If approved by the Engineer, provide spiral reinforcement cages in two pieces with added stock to provide for lapping the two adjoining ends at least one and one-half turns.

2472.4 METHOD OF MEASUREMENT

A Reinforcement Bars

The Engineer will measure *Reinforcement Bars*, including reinforcement in bar mats, by the weight incorporated into the structure in accordance with Table 2472-3. The Engineer will only include quantities for splices shown on the plans.

Reinforcement bars are marked in U.S. Customary sizes. The following table specifies the nominal dimensions of the bar:

Table 2472-3 Reinforcement Bars Theoretical Weights			
U.S. Customary Bar Size	Nominal Dimensions		
	Diameter *inches*	Area *in²*	Weight *lb/ft*
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.650
18	2.257	4.00	13.600

B Steel Fabric

The Engineer will measure *Steel Fabric* by the weight incorporated into the structure, based on the quantity shown on the plans. The Engineer will only include quantities for splices shown on the plans.

C Spiral Reinforcement

The Engineer will measure *Spiral Reinforcement* by the weight incorporated into the structure, based on the weight shown in the table in chapter 250 of the Bridge Construction Manual. The Engineer will only include quantities for splices shown on the plans.

D Couplers

The Engineer will measure *Reinforcement Bar Couplers* by the number of couplers installed as required by the contract and as directed by the Engineer.

2472.5 BASIS OF PAYMENT

The Department will pay for metal reinforcement at the contract unit prices for the contract items listed in the detailed specifications for the type of structure where the metal reinforcement is used. For structure type, with no detailed specifications, the Department will pay for metal reinforcement on the basis of the following schedule. The contract unit price for the relevant metal reinforcement contract item includes the cost of providing, fabricating, delivering, placing the metal reinforcement as specified in this section, bar supports, bar chairs, spacers, and tie wire.

The contract unit price for *Spiral Reinforcement* includes the cost of metal spacer strips, bar supports, and tie wires.

Item No.:	Item:	Unit:
2472.502	Couplers (Reinforcement Bars) T-___	each
2472.508	Reinforcement Bars	pound
2472.508	Steel Fabric	pound
2472.508	Spiral Reinforcement	pound

2501 PIPE CULVERTS

2501.1 DESCRIPTION

This work consists of the construction of pipe culverts using plant-fabricated pipe and appurtenant materials or using preformed structural plates fabricated for field assembly, installed primarily for passage of surface water through embankments.

2501.2 MATERIALS

A Pipe

Provide one of the following types of culvert pipe meeting the lowest strength class specified in the referenced specification, unless otherwise shown on the plans or specified in the special provisions. Provide special fabrication or jointing details as shown on the plans. Provide culvert pipe with the coating type shown on the plans or specified in the special provisions.

A.1 Corrugated Aluminum (CA) 3225

A.2 Corrugated Steel (CS) 3226

A.3 Corrugated Polyethylene (CP) 3247

A.4 (Blank)

A.5 (Blank)

A.6 Reinforced Concrete (RC) 3236

A.7 Polymeric Coated-Corrugated Steel (PC-CS) 3229

A.8 Corrugated Aluminized Steel (CAS) 3222

A.9 Polyvinyl Chloride (PVC) 3248

B Structural Plate

B.1 Corrugated Aluminum (CA) 3233

B.2 Corrugated Steel (CS) 3231

C Aprons

Provide aprons of the type required by the contract. The Contractor may provide and attach galvanized steel aprons to corrugated steel, corrugated polyethylene, polyvinyl chloride and polymeric coated-corrugated steel pipe, unless otherwise specified on the plans. The Contractor may provide and attach galvanized steel aprons to corrugated aluminum and corrugated aluminized steel pipe, if the Contractor applies geotextile Type II or other insulation material approved by the Engineer between the contact surfaces of the different materials.

C.1 Reinforced Concrete (RC) 3236

C.2 Galvanized Steel (GS) 3226

C.3 Aluminum Alloy (AA) 3225

C.4 (Blank)

C.5 (Blank)

C.6 (Blank)

C.7 (Blank)

C.8 Corrugated Aluminized Steel (CAS) 3222

D Flap Gates 3399

E Anti-seepage Diaphragms 3351

F Pipe Joint Sealer Materials

F.1 Preformed Rubber, Type A 3726

F.2 (Blank)

F.3 Bituminous Mastic 3728

G Granular Materials 3149

H Geotextile, Type II 3733

I (Blank)

J Reinforced Concrete Dissipator Ring 3236

2501.3 CONSTRUCTION REQUIREMENTS

Install pipe culverts in accordance with the following requirements:

A General

Excavate, construct foundations, backfill, and compact culvert(s) in accordance with the plans, 2451 "Structure Excavations and Backfills," and the following:

Remove and replace unsuitable foundation materials encountered at or below the foundation elevation using suitable replacement materials as directed by the Engineer. Install the replacement material in layers 6 inches thick per 2105, "Excavation and Embankment".

Compact materials used for bedding and foundation backfill in accordance with the plans and 2105, "Excavation and Embankment".

B Entrance Culverts

Remove and replace unsuitable foundation materials encountered at or below the foundation per 2501.3.A, "General." The Contractor may install entrance culverts without special bedding unless shown in the plans. Backfill using material meeting 2105.1.A.6, "Select Grading Material," and compact per 2105, "Excavation and Embankment".

C Laying Pipe

C.1 General

Lay pipe to the line and grade shown in the plans.

Terminate pipes that connect with inlet structures flush with the inside of the structure wall.

Jack culverts through the existing earth structure into position as shown on the plans or as approved by the Engineer. Ensure the flow line elevation at the starting point for jacking is within 0.1 ft of the staked grade. Do not reverse the flow line grade at any point. Ensure the line and grade at any point within the pipe does not vary by greater than ½ ft from the line and grade designated on the plans.

Provide any additional cover required to avoid damage to the pipe during construction. Maintain adequate cover until paving is completed, or until the installation is accepted by the Engineer if paving is not required. Repair or replace pipe damaged by contractor operations to the satisfaction of the engineer at no additional costs to the Department.

C.2 Metal Culvert

Lay corrugated metal pipes having circumferential joints with the outside laps pointing upgrade and with the longitudinal joints at the springlines.

Provide backfill material in accordance with the plan, modified to 100 percent passing the 3 inch sieve within 2 ft of the pipe.

Use metal connecting bands, centered over the joint, to join metal pipe sections. Place the pipe sections so that the pipe ends are abutting. Tighten the band to ensure a tight joint so that the soil does not infiltrate into the pipe and the sections do not pull apart.

Use approved fasteners, as defined in the applicable materials specifications, to assemble structural plate culverts as required by the manufacturer. Tighten bolts after assembly to a torque of 100 lbf•ft to 300 lbf•ft. Provide a calibrated torque wrench to demonstrate the adequacy of the bolt tightening, as approved by the Engineer.

Where beveled ends on metal pipe are shown on the plans or standard plates, cut the bevels at right angles to a vertical plane through the longitudinal axis of the pipe.

C.3 Concrete Culvert

Lay concrete pipe with the female end of each section upgrade. Tightly join the pipe sections so that the interior of the pipe sections abut each other.

Use preformed rubber or bituminous mastic elastic joint sealer material to provide flexible water-tight joint seals for concrete pipe. Where the pipe is designed to accommodate preformed gasket type seals, seal the joints with the preformed gasket as shown on the plans and meeting the performance requirements of 3726, "Preformed Plastic, Type B."

Where the pipe is not required to accommodate preformed gasket type seals, seal the joints with bituminous mastic and a full circumferential wrap of geotextile material extending at least 1 ft on each side of the joint. Secure the circumferential wrap against the outside of the pipe by metal or plastic strapping or by other methods approved by the Engineer.

Apply mastic joint sealer materials as recommended by the manufacturer. Wipe joints clean on the inside after sealing.

Plug lifting holes with a precast concrete plug, sealed and covered with mastic or mortar.

Use approved fasteners shown on Standard Plate 3145 to tie together concrete culvert sections unless otherwise shown on the plans or specified in the special provisions.

Provide backfill material in accordance with the plan, modified to 100 percent passing the 3 inch sieve within 2 ft of the pipe.

C.4 Plastic Culvert

Follow minimum cover, maximum cover, bedding, backfill and trench width requirements shown in plan details "Standard Flexible Pipe Bedding" and "PLASTIC PIPE INSTALLATION REQUIREMENTS".

Provide backfill material in accordance with the plan, modified to 100 percent passing the 1 inch sieve within 2 ft of the pipe. Use the embedment material to provide 1 ft minimum of fill over the pipe for a trench width as specified by the contract.

Place pipes and backfill in dry conditions by controlling the water conditions. Dewater groundwater and divert surface runoff to keep the water level below the pipe foundation.

Place pipes on the bedding starting at the downstream end with the female end of each section upgrade.

Make connections with bell and spigot joints using an elastomeric rubber seal (gasket) to provide water-tight joints that do not allow soil, silt, or water to migrate through the joint. Install joints so connected pipe sections form a continuous surface free of irregularities in the flow line. Tightly join the pipe sections so that the interior of the pipe sections abut each other. Keep gaskets and joint surfaces clean and free from soil during installation. Follow manufacturer's recommendation for fitting or coupling assembly and installation. Use a lubricant, if required, that will not deteriorate the gasket and pipe materials.

Before allowing vehicles or heavy construction equipment to travel over the pipe trench, maintain a minimum cover depth of material above the pipe of at least 2 ft and meeting the requirements of AASHTO LRFD *Bridge Construction Specifications*, Section 30, Table 30.6-1.

Perform deflection testing of all plastic pipe at least 30 days after installation. Remove obstructions such as sediment, standing water or safety grates that would interfere with deflection testing. Dewatering and additional work associated with preparing for and performing deflection testing is included in the bid price of the pipe.

Evaluate the pipe to determine if the specific internal diameter of the barrel has deflected more than 5 percent. Use the following methods to perform the deflection test unless specified in the plan:

(1) Visual inspection alone is not allowed for deflection testing.

(2) Use a nine-point mandrel approved by the Engineer to perform deflection testing for pipes. Pull the mandrel through the pipe using non-mechanical means.

(3) Direct measurements cannot be used for deflection testing unless specified in the plans and approved by the Engineer. Direct measurements can only be used on pipes with an inside diameter of 30 inches or greater. If the Department allows direct measurements, the Engineer must take measurements at randomly select locations, but at a minimum once every 10 ft throughout the pipe length and at the pipe ends. Visually inspect the pipe and take additional measurements at any location of observed anomaly or deflection. Ensure personnel making direct measurements meet confined space entry requirements in accordance with 1706, "Employee Health and Welfare."

(4) Laser scan inspection (laser ring) can be used to perform deflection testing when specified in the plans and approved by the Engineer.

The Engineer will not accept pipe that has a deflection of more than 5 percent or is damaged. Remove unacceptable pipe and reinstall new pipe or undamaged deformed pipe. Re-test the re-laid pipe for deflection at least 5 calendar days after embedment material is installed to grade.

Send deflection testing results to the State Hydraulic Engineer with the S.P. number, pipe location, material type, size, date built, date tested, and results from the mandrel test or other deflection test.

C.5 Extending In-Place Culverts

Clear in-place culverts of obstructions to water flow before placing the extension pipe. The Engineer will only require the removal of sediment to the extent that improved flow is likely to be maintained.

Follow backfill and bedding requirements for culvert material type.

If the pipe ends differ because of changed design, make the connection to the in-place culvert as shown on the plans or as approved by the Engineer.

Extend cast-in-place concrete box culverts with plant-fabricated pipe using the detailed connections as shown on the plans.

Use a transition section as shown on the plans if extending a box-type concrete cattle pass with precast concrete sections. Expose the ends of the in-place structure and remove concrete as shown on the plans. Construct the cast-in-place portion of the transition in accordance with 2411, "Minor Concrete Structures."

D Backfilling Excavations

Backfill excavations to the required extent shown on the plans and at the appropriate time. Uniformly distribute suitable backfill materials in 6 inch layers. Compact backfill in accordance with the plans and 2105, "Excavation and Embankment", before placing successive layers.

Within the roadcore, if the contract does not specify special backfill materials, use materials meeting 3149.2.D.1, "Granular Backfill," placed within 18 inches of the sides and 12 inches above the top of the structure (note that plastic culverts require 1 inch minus material, regardless of culvert location). For the remainder of the backfill, use embankment material meeting 2105.1.A.6, "Select Grading Material." If outside the roadcore, use suitable material meeting 2105.1.A.6, "Select Grading Material."

Do not place backfill material on a frozen foundation or when the material may freeze during the placement or compaction work.

Step the sides of the excavation, if steeper than 4:1 and if potential wedging action of the backfill may be detrimental to the structure. If the contract does not require specific maximum dimensions for the excavation, the Contractor may enlarge the excavation and flatten the side slopes for convenience of backfill and compaction operations, at no additional cost to the Department.

Backfill uniformly in horizontal layers throughout the excavation area. Maintain the sides of the excavation and prevent voids in the backfill when removing shoring or bracing from the excavation.

E Culvert Appurtenances

Provide and install appurtenant items such as aprons, safety aprons and grates, diaphragms, dissipator rings, flap gates, and safety grates, including special grates for concrete pipe and large size pipe, trash racks, and other similar devices requiring a special design, as shown on the plans or the special provisions.

F Induced Trench Installation

Construct backfill over the culvert, if shown on the plans and in accordance with the following:

Construct the embankment in accordance with 2105, "Excavation and Embankment," for a width on each side of the installed culvert at least equal to three pipe widths and to an elevation over the top of the culvert equal to the pipe height plus 1 ft. When using 2105.3.F.1, "Specific Density" method, compact the embankment to a density not less than 100 percent of maximum density.

Excavate a trench to a level 1 ft above the top of the culvert, for the width and length of the pipe, and with vertical sides. Loosely fill the trench with highly-compressible clay soil before constructing the remaining embankment in accordance with 2105, "Excavation and Embankment."

G Culvert Cleaning

Clean sediment and debris from culvert(s) before final acceptance.

2511 RIPRAP

2511.1 DESCRIPTION

This work consists of providing and placing stone riprap, with or without grouting, as a protective covering on earth slopes, piers, abutments, walls, or other structures, where the soil is susceptible to erosion.

The Department classifies riprap by type as random riprap or handplaced riprap, depending on the method of placement and the stone size specified.

2511.2 MATERIALS

A Riprap Materials 3601

B Filter Materials

B.1 Granular Filter 3601

B.2 Geotextile Filter 3733

C 3A-Grout 2461

2511.3 CONSTRUCTION REQUIREMENTS

A General

Provide and place stone riprap as shown on the plans or as directed by the Engineer.

Excavate and shape the foundation for the riprap, with or without filter material, to the cross-sections as shown on the plans, unless otherwise directed by the Engineer. Compact loose foundation material before placing the riprap or filter material.

If the contract requires, place a layer of riprap at least a 1 ft thick on a filter material, unless otherwise required by the contract or directed by the Engineer.

Grout riprap as required by the contract or as directed by the Engineer. Place the riprap on a filter layer consisting of granular material or geotextile. Fully grouted riprap is not allowed in public waters.

B Filter Material

Place filter material under the riprap unless otherwise required by the contract. The Contractor may choose the type of filter material, except as required by the contract.

B.1 Granular Filter

Spread granular filter material to a minimum thickness of at least 6 inches over the prepared foundation, or as required by the contract. Deposit granular material, placed under water, directly on the foundation using a bucket or similar container. Do not discharge the granular material above the water surface.

B.2 Geotextile Filter

When placing geotextile filter material ensure that the foundation surface is relatively smooth and free of stones, sticks, and other debris or irregularities that might puncture the fabric. Place the filter material and conduct construction operations without tearing, puncturing, or shifting the fabric.

Place the fabric with the longest dimension parallel to the direction of water flow. If using fabric that is not seamed, overlap splices and joints at least 18 inches, except overlap splices and joints placed under water 36 inches. Provide shingled joint laps in the flow direction and from top to bottom of a slope to direct water flow over the joint without undermining the geotextile filter. The Contractor may sew multiple fabric pieces together, as specified in 3733, "Geotextiles," in lieu of joint overlapping. Bury the upgrade edges of the fabric a minimum of 6 inches to direct water flow over the fabric and prevent undermining. If not seamed, place washered steel pins, edge stakes, stones, or other material at locations and in quantities as approved by the Engineer, to prevent movement of the geotextile filter during placement of the riprap.

Do not dump stone at the top of the slope and roll stone down the slope. If placing stones directly on the geotextile filter without a granular cushion, do not operate equipment on top of the stones after placement. Do not operate construction equipment directly on top of the geotextile.

Do not use geotextile filter material under hand placed or grouted riprap, unless otherwise required by the contract.

The Contractor may place geotextile filter on slopes no steeper than 1:3. For slopes steeper than 1:3, retrench the geotextile at least every 15 ft or as required by the contract. Do not use geotextile filter on slopes steeper than 1:2.

C Riprap Stone

Do not drop stones on the fabric from a height greater than 1 ft unless the fabric is covered with a 6 inch thick granular cushion course. If covered, the Contractor may drop riprap stones from a height no greater than 3 ft.

When placing riprap, start at the lowest elevations and work upwards.

Before placement of riprap stone on geotextile, the Engineer may require the Contractor to demonstrate that the placement methods will not damage the fabric. The Engineer may order the removal of at least 4 sq. yd of riprap to inspect for fabric damage in accordance with 1511, "Inspection of Work."

C.1 Random Riprap

Position random riprap to provide a uniform distribution of the various sizes of stone and produce a dense, well-keyed layer of stones with the least practical voids volume. Level the surface flush with the surrounding ground to produce a reasonably uniform appearance and the thickness required by the contract.

Wash riprap clean before placing underwater.

C.2 Hand-Placed Riprap

Embed the stones for hand-placed riprap in the foundation material, with the axis of the stone that most nearly approximates the contract-required thickness of riprap laid perpendicular to the foundation slope. Lay stones with the least practicable space between them. Position the stones to stagger the joints up the slope. Place each stone to allow the foundation material and adjacent stones to carry its mass.

Use selected stones set to line and grade to define the ends and edges of each riprap area.

After laying the larger stones, fill the spaces between the stones with firmly seated, smaller stones to produce a uniform surface.

Wash riprap clean before placing underwater.

D Grouting

For fully grouted riprap, ensure that grout fills the spaces between stones throughout the entire thickness of the riprap.

Immediately before placing the grout for grouted riprap, thoroughly wet the stones with water. Do not pour grout over stones that have become surface dry. Sweep the surface of the grouted riprap with a stiff broom to finish.

E Thickness Requirements

Ensure the riprap placed on each separate area has a minimum thickness of at least 80 percent of the thickness required by the contract and an average thickness of at least 95 percent of the thickness required by the contract when measured at right angles to the face.

2557 FENCING

2557.1 DESCRIPTION

This work consists of constructing fences.

2557.2 MATERIALS

On contracts not specifying types of material for metal fencing products, the Contractor may select the type of material. Use the same type of metal fence components on the entire project.

Cap tubular metal posts.

If the contract requires coated metal posts, use the same coating on posts, post supports, rails, gate frames, expansion sleeves, and other hardware items or fittings in accordance with the following:

(1) Zinc coating with zinc coated fence fabric,
(2) Aluminum or zinc coating with aluminum coated steel fabric, and
(3) Vinyl coating with vinyl coated fence fabric.

Provide black vinyl coated posts, hardware, and fabric with a low to medium gloss, unless otherwise shown on the plans.

Use aluminum alloy posts, rails, frames, and other hardware items with aluminum alloy fence fabric.

A brace assembly consists of a single wood or metal brace, installed as a leg brace or as a horizontal brace between two consecutive posts, including the required brace plate or concrete anchor, post anchorages, and guy wires or truss rods. A brace assembly for a chain link fence consists of two brace bars and a truss rod.

A Fence Wire.....3376

B Fence Gates.....3379

C Fence Posts

C.1 Rolled Steel Posts.....3403

C.2 Structural Metal Posts.....3406

C.3 Vacant

C.4 Treated Wood Posts.....3413

D Hardware and Fittings.....3406

E Concrete

Provide concrete in accordance with 2461, "Structural Concrete," Grade B, Type 3 concrete.

2557.3 CONSTRUCTION REQUIREMENTS

A General

Remove and dispose of brush, trees, and other obstructions that interfere with construction of the fence in accordance with 1405, "Use of Materials Found on the Project," 2101, "Clearing and Grubbing," and 2104.3.C, "Removal Operations." Provide a smooth ground profile at the fence line.

Ensure the bottom of the fence follows the contour of the ground. At small stream crossings, drainage ditches, and other locations where the bottom of the standard size fence cannot conform to the ground contour, construct the fence to span the depression and use extra wire or fabric to close the space below the bottom of the fence, unless otherwise shown on the plans or directed by the Engineer. Provide and install longer posts with intermediate posts, stakes, braces, extra fabric, or wires to span the depression.

Perform field repairs to fence materials as recommended by the manufacturer.

B Installing Posts, Rails and Braces

B.1 General

Set posts plumb, except set posts perpendicular to the slope of the ground at locations as directed by the Engineer.

Install corner posts, pull posts, end posts, and gate posts at locations shown on the plans or as directed by the Engineer. Provide corner post assemblies at horizontal angle points with deflections greater than 20 degrees. Space pull posts to provide a braced post at points where the following occurs:

(1) The vertical alignment deflects by greater than 20 degrees,
(2) The post anchorage is necessary to counteract wire uplift, and
(3) An abrupt grade change on short runs that cannot be avoided by shaping the ground to a uniform contour.

When driving fence posts, protect the post tops from damage. Remove and replace posts damaged during installation.

Anchor posts placed on concrete walls, curbs, or other concrete structures as shown on the plans.

If placing fence posts in solid rock, set the post at least 12 in [300 mm] into the rock or with the post bottom at the elevation shown on the plans, whichever requires the lesser excavation into the rock. Cut the post bottom to provide the height above the ground surface as shown on the plans. Cut holes in rock to provide a clearance of at least 1 in [25 mm] around the posts. Fill the holes around the posts with grout consisting of one part portland cement, two parts mortar sand, and sufficient water to create the proper consistency. The Contractor may add 0.1 part hydrated lime in the grout.

Place and consolidate concrete around the posts and braces. Allow the concrete to cure for at least 3 calendar days before installing the fence wire.

The Contractor may pour the concrete into prebored holes without forming, if no concrete contamination occurs during placement.

Except as otherwise required for posts and braces set in rock or concrete, backfill the annular space around posts set in prebored holes in layers using selected material from the excavation with each layer thoroughly compacted to produce a rigid post setting. Use other backfill material, if required by the contract.

Dispose of surplus excavated material in low areas along the fence line or as directed by the Engineer. Neatly finish the adjacent area.

B.2 Metal Post Installations

Set posts for chain-link fabric fencing in concrete as shown on the plans. The Contractor may drive line posts if the post lengths provide a post embedment of at least 4 ft [1.2 m] into the ground.

Drive rolled steel line posts.

The Contractor may provide rolled steel end posts, corner posts, and pull posts, including the required braces, with anchor plates and brace plates. Set the posts in dug holes. The Contractor may omit the anchor and brace plates and set the posts and braces in concrete. Backfill excavations around the posts and braces using the excavated material. Thoroughly compact the backfill.

Set rolled steel gate posts in concrete.

Provide and install metal post extensions in the lengths directed by the Engineer at the locations shown on the plans. If post splicing is necessary, use a standard thread and coupling of the same material to thread and join the pipe ends at the splice. Avoid splicing in the exposed upper portion of the post. Provide a suitable plug in the bottom end of each extended post.

B.3 Wood Post Installations

The Contractor may drive posts or set wood posts in prebored holes. Place the larger end of the post in the ground. When driving posts, place the square cut or pointed end in the ground. Except for holes in rock, cut post holes to a diameter providing a clearance of at least 3 in [75 mm] around the post to allow backfill and compaction.

Provide wood braces in accordance with 3413, "Wood Fence Posts (Treated)." Provide wood braces with diameters at the small end equal to the minimum permissible diameter as shown on the plans. Ensure the diameter at the small end does not exceed the top diameter of the smaller adjacent post.

C Installing Fence Wire

Install and pull tight the fence wire as recommended by the manufacturer.

C.1 Chain Link Fabric

Place chain link fabric in continuous runs between corner, end, and gate posts. Install the fabric on the side of line posts that face away from the main road except as otherwise directed by the Engineer. Ensure impacts from snow plowing stress the posts rather than the fasteners.

At ends of chain link fabric, thread a stretcher bar through the fabric loops and use clamps to fasten the bar to the posts as shown on the plans.

Weave pre-bent wire of the same kind as the fabric to make splices in the chain link fabric.

C.2 Barbed Wire and Woven Wire

Unless otherwise directed by the Engineer, place barbed wire and woven wire installed on tangent alignment or on curves no greater than 1 degree on the side of line posts that faces away from the main road. If placing the fence on horizontal curves greater than 1 degree, place the wire on the side of line posts on the outside of the curve. Offset posts at corners to the inside so that the wire will bear against the post.

Fasten fence wire to end, corner, gate, or pull posts before fastening to intermediate line posts. Stretch woven wire to make longitudinal wires taut and to remove 30 percent of the factory fabricated fence crimp.

When required by the plans, cut and splice woven wire at the pull posts to obtain and maintain uniform tension in horizontal wires. The Contractor may use a wire crimping tool to increase the number or depth of tension curves to maintain tension in horizontal wires.

Use wire clips or clamps in accordance with 3376, "Fence Wire," to fasten wires to metal line posts. Use galvanized staples to fasten wires to wood posts. Where the wire loops around end, corner, or pull posts, wrap the wire around the post at least four complete turns.

Use U-shaped wire staples at least 1¾ in [45 mm] long in pine posts and at least 2 in [50 mm] long in cedar posts. The Contractor may use L-shaped staples with serrated, barbed or ring shanks at least 1½ in [38 mm] long.

Diagonally drive U-shaped staples across the wood grain to prevent both points from entering between the same grain. Slope staples upward, against the pull of the wire, in depressions with wire up-lift. Slope staples downward on level ground and over knolls. Staple the wires at corner, end, and pull posts. On line posts, drive the staples to the point that allows movement of the wire. Do not damage the wire while driving the staples.

To splice wire between posts, use an approved splicing sleeve as indicated in 3376, "Fence Wire," or wrap each wire end around the other wire from 4 turns to 6 turns to form a lasting connection. Use a splicing tool in place of hand wrapping to obtain uniformly tight wraps as directed by the Engineer.

If using splicing sleeves on woven wire, maintain the same horizontal distance between vertical wires as in the fabricated wire. If using the wrap method to splice woven wire, allow the two end stay wires to abut each other and enclose the wires within the wrap.

D Installing Gates

Install gates designed to allow locking with a Department-provided padlock and equipped with a padlock keeper at the locations shown on the plans.

E Electrical Grounds

Install electrical grounds consisting of copper coated steel rods with a nominal diameter of at least ⅝ in [15 mm] and a length of at least 8 ft [2.4 m] along each fence line at the staked locations.

Drive ground rods to an elevation flush with the ground surface at points directly below or adjacent to the fence wire. Connect each ground rod to the fence with a solid No. 6 copper wire. Use approved type metal clamps as indicated in 3376, "Fence Wire," to attach the ground wire to the ground rod and to the fence wires to electrically ground each longitudinal fence wire. The Department will not require greater than one connection on woven wire and chain link fabric near the bottom at each ground rod.

Install electrical grounds in the following locations:

(1) On each fence line at the point of crossing beneath an electric power line.
(2) Two grounds at each pedestrian gate, one on each side of the gate opening, as close to the gate posts as practicable.
(3) Additional grounds on each fence line to maintain spacing between grounds of 1,500 ft [450 m] on fences with metal posts and 1,000 ft [300 m] on fences with wood posts.
(4) At least one electrical ground on each separate section of fence. The Department defines a separate section of fence as a run with unbroken electrical continuity.
(5) On each separate section of fence, uniformly space electrical grounds and locate a ground within a distance from each end no greater than half of the desired maximum spacing interval.

2573 STORM WATER MANAGEMENT

2573.1 DESCRIPTION

This work consists of managing storm water runoff and project related water discharges to minimize sediment pollution and managing the discharges associated with dewatering and basin draining activities.

2573.2 MATERIALS

A (Blank)

B Water Treatment **3875**

C Mulch **3882**

D Silt Fence **3886**

E Flotation Silt Curtain **3887**

F Temporary Slope Drain **3892**

G Sandbags **3893**

H Sediment Control Log **3897**

I Flocculants **3898**

J Filter Berm **3874**

2573.3 CONSTRUCTION REQUIREMENTS

A General

Manage stormwater by routing of water, temporary diversions/flumes, bypasses, and avoidance measures. Schedule, construct, maintain, or install temporary sediment control and storm water management measures as required by the contract.

Adjust the installation location of temporary stormwater management and sediment control devices, as shown on the plans, to better accommodate the actual field conditions and increase the effectiveness of a device.

A.1 Erosion Control Supervisor

Provide an Erosion Control Supervisor with a valid Minnesota Erosion and Stormwater Construction Site Management certification, authorized to represent the Contractor regarding meeting contractual requirements for Erosion and Stormwater Management and work in public waters. The certification is obtained from a MnDOT approved provider.

The Erosion Control Supervisor shall be available to the work site within 24 hours of initial disturbance and at the site daily when work is taking place until final stabilization. The following list describes the duties of the Erosion Control Supervisor:

(1) Implements the quality control program per 1717, "Air Land and Water Pollution,"
(2) Ensures proper installation, functionality, and maintenance, clean-up, and removal of all erosion and sediment control Best Management Practices (BMPs) and in accordance with manufacturer's recommendations,
(3) Implements the erosion and sediment control schedule,
(4) Coordinates the work of subcontractors and ensures the full execution of erosion and sediment control measures for each operation and stage of work,
(5) Oversees the work of subcontractors and ensures the subcontractors undertake erosion and sediment preventive measures at each stage of the work,
(6) Attends construction meetings to discuss the erosion control schedule and inspections,
(8) Provides for erosion and sediment control methods for temporary work not shown on the plans,
(10) Ensures effective preventative BMPs are in place, recommends BMP changes for the Engineer's approval, and amends the SWPPP per 1103, "Definitions," or construction plan sheets to document changes,
(11) Ensures acquisition of and compliance with applicable permits for borrow pits, dewatering, and temporary work in rivers, lakes and streams,
(12) Ensures the full installation of erosion and sediment control work before suspension of the work,
(13) Coordinates with federal, state, and local regulatory agencies on resolution of erosion and sediment control issues resulting from the work,
(14) Ensures that proper cleanup occurs from vehicle tracking on paved surfaces locations where sediment leaves the right-of-way,
(15) Ensures daily compliance with environmental laws, permits, and contract requirements, and

(16) Ensures that installers of erosion and sediment control have proper certifications per 2573.2.A.2.

The Erosion Control Supervisor is authorized to install, fix, or repair erosion or sediment control practices when a certified installer is unavailable.

A.2 Certified Installers

Provide a certified installer to install or to direct installations of erosion or sediment control practices and for the following:

(1) Seeding,
(2) Sodding,
(3) Mulching,
(4) Silt fence or other perimeter sediment control device installations,
(5) Rolled Erosion Control Products (RECP) installation,
(6) Hydraulic Erosion Control Product installation,
(7) Silt curtain installation,
(8) Ditch check installation, and
(9) Compost installation.

Provide at least one installer with a valid Minnesota Erosion and Stormwater Construction Installer Certification at the time of installation. The certification is obtained from a MnDOT approved provider.

A.3 Areas of Environmental Sensitivity

Schedule and phase construction in and around Areas of Environmental Sensitivity (AES), as shown on the plans to minimize the potential of sediment entering into these areas. Use measures such as hand clearing and grubbing, limiting bare soil exposure time, expediting construction activities, and immediately establishing final vegetation to minimize sediment loss potential.

A.4 Construction of Temporary Sediment Basins and Traps

Construct temporary sediment basins concurrently with the start of soil disturbing activities. Direct storm water runoff from drainage areas to the basins. Stabilize the exposed side slopes of the basins. Provide an outlet to the basin that discharges water from the surface, separates floatables, and provides scour protection or energy dissipation.

A.5 Temporary Sediment Control Measures

Install perimeter, inlet, and exit sediment control measures before, or in conjunction, with soil disturbing activities.

Recover sediment, restore property to the pre-existing conditions for loss of sediment off the project, or both at no additional cost to the Department.

A.6 Dewatering and Pumping

Provide a water treatment plan for turbid or sediment laden water. Submit the water treatment plan to the Engineer before pumping. Do not begin work until the Engineer accepts the water treatment plan including any contractor required permits. Include in the water treatment plan the use of sediment traps, vegetative filter strips, flocculants, or other water treatments per 3875, "Water Treatments".

Protect the discharge location of the dewatering process from erosion. Unless otherwise required by the contract, provide and install the BMPs to control erosion and suspended sediment during the dewatering or pumping operation.

A.7 Suspension of Grading

Shape exposed soil and incorporate temporary and permanent erosion control measures as approved by the Engineer before suspending grading operations.

A.8 Related Work

Control drainage, erosion, and pollutants on the work related to the Project including: haul roads, temporary construction, waste disposal sites, plant and storage locations, and borrow pits other than commercially operated sources. Maintain the area, shape the area, install temporary BMPs, replace topsoil, and establish vegetative cover on areas where the potential for pollution has been increased due to the Contractor's operations. Waste disposal sites, borrow pit areas or other related work located outside of the Right-of-Way may require separate permits.

B Silt Fence Installation

B.1 Type PA Preassembled

Install preassembled silt fence with attached wooden stakes in small areas less than ¼ acre. Pound stakes at least 1.5 ft. into the ground. Install the geotextile with the selvage edge on top. Place the bottom edge of the geotextile into a trench 6 in. deep and 6 in. wide. Backfill and tamp the trench for compaction.

B.2 Type MS Machine Sliced

Mechanically install the geotextile with the selvage edge on top. Place the geotextile directly behind the soil-slicing blade as it works to achieve consistent placement and depth. Do not plow soil if using the slicing method. Roll the wheels of a tractor or skid steer on each side of the geotextile at least 2 times to compact the soil immediately next to the geotextile

Install posts adjacent to the back face of the geotextile with the post studs facing away from the geotextile fabric. Secure each post by inserting three plastic ties through the geotextile. Space the posts a maximum of 6 ft. on center.

B.3 Type HI Hand Installed

Install the geotextile by hand with the selvage edge on top in areas inaccessible by a machine. Install the bottom 8 in. to 12 in. of the geotextile with one of the following methods:

(1) Place the geotextile fabric into a trench 6 in. deep and 6 in. wide with the bottom edge of the geotextile wrapping back up to the soil surface. Backfill and compact soil, or

(2) In areas where soils prohibit hand trenching, place the geotextile on the ground on the front face and covered with crushed rock or p-gravel at least 12 in. wide and 6 in. high to provide for as a filter.

Install posts adjacent to the back face of the geotextile with the post studs facing away from the geotextile fabric. Insert three plastic ties to secure it to each post. Space the posts a maximum of 6 ft. on center.

B.4 Type SD Super Duty

Place the bottom edge of the geotextile from 4 in. to 6 in. underneath the face of the median barrier exposed to direct storm water runoff. Place the median barriers end to end to minimize the gap between each barrier. Attach the geotextile to the face of the barrier with wire or plastic ties and tie to each eyelet on the barrier.

B.5 Type TB Turbidity Barrier

Use turbidity barriers to isolate the work zone from the watercourse. Install the turbidity barrier as close to the work area as possible but not in expected water depths greater than 2 ft. deep (includes wave heights). Do not trench the geotextile into the watercourse. Anchor at least a 1 ft. flap folded up-gradient with sandbags per 3893, "Sandbags," to seal the bottom edge. In the top edge, insert a steel support cable into a 2 in. double stitch sleeve and fastened to steel fence posts per 3403, "Hot-Rolled Steel Fence Posts."

Install posts adjacent to the back face of the geotextile with the studs facing away from the geotextile fabric. Secure each post by inserting three plastic ties through the geotextile.

Before removing the turbidity barrier, remove and dispose of material not originally in the isolation zone in a location approved by the Engineer.

C Bale Barrier Installation

Trench bales into the ground 4 in. and stake with two wood stakes per bale. Provide the stakes in a length that allows the placement of the stake so the top of the stakes remains flush with the top of the bale when embedded into the ground at least 10 in. Provide Type 3 mulch per 3882 "Mulch Material, "for bale material unless otherwise specified in the plans. Place bale joints tight together. Provide a category 3 erosion control blanket as a wrap around the bales extending 1 ft. at the base on each side. Provide staples to secure blanket to ground.

D Sandbag Barrier Installation

Install sandbags on a level contour. Sandbags installed a minimum of 6 ft. back from the toe of the slope to allow ponding, and to provide room for sediment storage. Stack sandbags at least three bags high. Butt ends of bags tightly together and overlap butt joints of rows beneath with each successive row. Stack bags in trapezoidal shape with respect to the side profile.

E Filter Berm Installation

E.1 Type 1, Type 2 (Compost, Slash Mulch)

For slope breaks and perimeter control, install filter berms along the contour of the slope and perpendicular to sheet flow. Install the filter berms so the beginning and end of the installation points slightly up the slope to create a "J" shape at each end to contain runoff from above and prevent it from flowing around the ends of the berm. For slopes that receive runoff from above, place a filter berm at the top of the slope to control the velocity of the flow running onto the slope, and to spread the runoff into sheet flow.

For ditch checks, install perpendicular to the ditch gradient such that the top of the berm in the middle of the ditch is lower in elevation than the bottom of the terminating points on the ditch side slopes.

Upon formation, immediately seed compost filter berms.

E.2 Type 3 (Rock Weeper)

Line the bottom of the rock weeper with a Type IV geotextile per 3733, "Geotextiles." Provide a rock weeper that forms a trapezoidal-shaped berm. Install coarse filter aggregate per 3149, "Granular Material," on the front half of the berm. Install Class I riprap per 3601, "Riprap Material," on the back half of the berm.

For ditch checks, install perpendicular to the ditch gradient. Construct the center section of the rock weeper 6 in. lower than the end points of the weeper at the ditch side slopes to form a weir.

For permanent ditch checks, reduce the height to 16 in. and modify the side slopes to 1:6 (V:H).

E.3 Type 4 (Topsoil)

For perimeter control, construct a topsoil berm using topsoil salvaged from the project. Immediately following formation, stabilize the berm with seed and mulch or an equivalent approved by the Engineer.

E.4 Type 5 (Rock)

Install Class II riprap on top of a Type IV geotextile liner per 3733, "Geotextiles." Configure riprap in a trapezoidal-shaped berm.

For ditch checks, install perpendicular to the ditch gradient. Construct the center section of the rock berm 6 in. lower than the end points of the rock berm at the ditch side slopes to form a weir.

For permanent ditch checks reduce the height to 16 in and modify the side slopes to 1:6 (V:H).

F Sediment Control Log Installation

F.1 Straw, Wood Fiber, and Coir

Place logs on smooth prepped soils and prepare a shallow trench for the sediment control log to be placed. Backfill and compact the upgrade side of the sediment control log with soil. Stake logs through the back half of the log at a 45 degree angle with the top of the stake pointed upstream. Stakes shall be spaced every 2 ft. If using more than one sediment control log for length, overlap the ends 6 in. and stake both ends.

F.2 Wood Chip, Compost, and Rock

Place logs on smooth, prepped soils or paved surfaces and ensure no gaps are between logs and soil or paved surface. Install logs along contours with ends turned up slope in a J-hook manner.

F.3 Wood Fiber and Blanket System

For Ditch checks install Category 3 (wood fiber) Erosion Control Blanket (ECB) per 3885, "Rolled Erosion Control Products," or as show in plan, at least one role width, perpendicular to the ditch flow. Burry the leading edge in a trench 4 in. deep and 4 in. wide. Backfill and compact the trench with soil. Staple the ECB at spacing no greater than 1 ft. on center.

Place the Sediment Control Log type Wood Fiber per 2573.F.1, without the trench, on top of the ECB. If using more than one sediment control log for length, overlap the ends 6 in and stake both ends. Follow additional ditch check installation as per 2573.F.4.

F.4 Ditch Checks

Follow installation above for sediment control log type Wood Fiber, Wood Chip, Compost, or Rock and place perpendicular to flow and in a crescent shape with ends facing upstream. Use logs with a center section of the ditch check one log diameter lower than the ends. Space stakes every 1 ft. Provide 2 stakes in a crisscross pattern at each location with the sediment control log in-between.

G (Blank)

H (Blank)

I Flotation Silt Curtain Installation

Provide a flotation silt curtain meeting the following requirements and characteristics:

(1) Contains connecting devices at each end so that sections can be joined together,
(2) Contains connecting devices designed to prevent silt from permeating through the connection and at the specified strength to prevent ripping out,
(3) Installation shall reach the bottom of the water body, and
(4) Offset connection joints between rows when more than one row is installed.

I.1 Still Water

Secure both ends of a Light Duty Floating Silt Curtain to land with steel fence posts per 3403, "Hot-Rolled Steel Fence Posts," and extend the curtain at a 45 degree angle from both ends. Anchor the curtain in the waterway with at least 40 lb.

anchors at intervals no greater than 100 ft. along the length of the curtain. Mark each anchor with a buoy in navigable waters. Keep the curtain as tight to the work area or shoreline as possible not to exceed one-fourth of a stream width.

I.2 Moving Water

Secure both ends of a Heavy Duty Floating Silt Curtain per 3887, "Flotation Silt Curtain," to land with steel fence posts per 3403, "Hot-Rolled Steel Fence Posts," and extend the curtain at a 45 degree angle from both ends. Anchor the curtain in the waterway with at least 150 lb. anchors at intervals no greater than 50 ft. along the length of the curtain. Mark each anchor with a buoy in navigable waters. Keep the curtain as tight to the work area or shoreline as possible not to exceed one-fourth of a stream width.

J (Blank)

K Construction Exit Controls

Select Exit controls from the following list of stabilized construction exits:

-Slash mulch,
-Crushed Rock,
-Temporary paving,
-Reinforced geotextile,
-Sheet pads,
-Floating road,
-Timber pad,
-Rumble pad.

Use construction exit control BMPs at exit locations to minimize vehicle tracking of sediment from the project onto paved surfaces. Install BMPs during the initial phase of the project.

Select construction exit BMP based on project site conditions, soil type, vehicle size, time of year, and duration of use. Used materials generated by the project as construction exit controls whenever possible. Maintain exit controls during the project.

Clean paved streets at the end of each working day, or more frequently as necessary to provide safety to the traveling public.

K.1 Wheel Wash Off

Provide a wheel wash off system in addition to stabilized exit controls when project site conditions warrant.

L Culvert End Controls

L1 Inlet

Provide culvert inlet end sediment trap and volume controls consisting of the BMPs and devices for temporary impoundment and treatment of construction stormwater upstream. Culvert inlet end controls apply to median culverts, centerline culverts, box culverts, and entrance culverts.

L.2 Outlet

Provide culvert outlet ends with energy dissipation devices, transition devices, or both.

M Storm Drain Inlet Protection

Implement BMPs and devices to protect storm drain inlets for all stages of work to prevent passage of sediments into and through underground drainage systems.

Protect storm drain inlets, including manholes, catch basins, curb inlets, and other type inlets constructed for the ingress of surface water runoff into underground drainage systems.

Install storm drain inlets with sediment capture devices before soil disturbing activities. Provide effective storm drain inlet protection until the completion of paving or final stabilization of soils.

Prevent or minimize the potential for unsafe flooding or siltation problems. Clean out devices regularly and provide devices with an emergency overflow to reduce the flooding potential. Place devices without creating driving hazards or obstructions.

N Flocculants

Apply flocculants in conjunction with installed sediment and erosion control BMP's. Do not apply flocculants directly to public waters (i.e. lakes, wetlands, streams). Apply flocculants in a contained area and assure thorough mixing into the water. Before applying a flocculant, test the pH and temperature of the storm water. Apply flocculant within the manufacturer's specified ranges. Allow from 15 to 20 min retention time for clay size particles to settle, ensuring that the discharge of the treated water is visually the same as the receiving water.

N.1 Liquid Flocculant

Hydraulically apply liquid flocculant over the surface of the water to be treated. Dilute the liquid flocculant concentrate to form a stock solution. Apply the stock solution at the manufacturer recommended rate to yield 1 ppm in the final treated water volume.

N.2 Flocculant Sock

Securely anchor the flocculant sock in an area where the water to be treated will flow over the sock. Do not leave flocculant socks in standing, stagnant water.

N.3 Granular Flocculant

Mix granular based flocculant with water in a tank to form a stock solution. Hydraulically apply the stock solution at the manufacturer's recommended rate to yield 1 ppm in the final treated water volume.

O Temporary Slope Drains

Provide temporary slope drains to convey concentrated runoff down the face of a cut or fill slope to reduce erosion on or below the slope. Provide a minimum slope on pipe of 3%. Size the pipe to the appropriate drainage area. Maximum allowable drainage area is 5 acres per slope drain. Provide an earthen dike to channel the flow to the temporary slope drain. Construct the top of the earth dike 1 foot higher than the top of the inlet pipe. Provide anchors for the pipe and space no greater than 8 ft. apart. Use a watertight connection to attach the flared end section to the inlet end of drain pipe. Extend temporary pipe beyond the toe of slope and terminate in a 4 foot level section where practicable. Provide a riprap apron outlet and sediment trap for energy dissipation.

P Maintenance

Keep all devices functioning properly and maintained in accordance with the Contract. Repair or replace plugged, torn, displaced, damaged, or nonfunctioning devices. Remove sediment from sediment control devices when the sediment reaches one-half of the height of the device. Replace or repair devices damaged or compacted by equipment. Perform repair or sediment removal within 24 hours of discovery or as soon as field conditions allow access.

P.1 Filter Berms

Expand, enlarge, or augment the filter berm with additional erosion and sediment control practices if concentrated flows bypass or breach the berm or to maintain the dimensions of the berm.

P.2 Sediment Basins and Traps

Drain the basin and remove the sediment when the depth of sediment collected in the basin reaches 50 percent of the storage volume determined by the outfall device. Complete drainage and removal within 72 hours or as soon as field conditions allow access. Remove sediment to the original designed or excavated grade or as necessary to restore the function of the device. Restore stabilized condition of side slopes and access road.

Clean out and shape temporary sedimentation basins intended for use as permanent water quality management basins as shown on the plans.

P.3 Storm Drain Inlet Protection Devices

Clean, remove sediment, or replace storm drain inlet protection devices on a routine basis to ensure the full functionality of the devices for the next rainstorm event.

P.4 Culvert Inlet End Control Devices

Clean, remove sediment, or replace culvert inlet end control devices on a routine basis to ensure the full functionality of the devices for the next rainstorm event.

Q Water Treatments

Use properly sized floating head skimmers to withdraw collected waters from the surface. Tether floating skimmer to maximize surface water withdraw and maintenance functionality. Install stop system to prevent floating head embedment into sediment. Install and attach skimmer pipe outfall to new or existing structure, berm underdrain, or as site conditions allow.

R Removal of Temporary Devices

Remove temporary sediment control devices after completing the work unless otherwise required by the contract or directed by the Engineer. All removed materials become the property of the Contractor.

Spread accumulated sediment to form a suitable surface for turf establishment or dispose of the sediment. Shape the area to permit natural drainage as approved by the Engineer.

Remove the silt curtain upon completion of work. Do not allow re-suspension of sediment or loss of trash and oil into the water during the silt curtain removal.

2574 SOIL PREPARATION

2574.1 DESCRIPTION

This work consists of providing temporary shaping and grading, and preparing the soil for permanent turf establishment to reduce the risk of soil erosion. Temporary shaping and grading includes directing water flow and breaking up soil fine enough to install temporary erosion control materials. Preparing the soil for permanent turf includes soil tilling and soil additives.

2574.2 MATERIALS

2574.3 CONSTRUCTION REQUIREMENTS

A General

Prepare the soil to minimize soil erosion and to provide a media for plant and root establishment. Perform soil preparation operations for permanent seed and sod and for temporary conditions.

A.1 Erodible Surface

The Department shall withhold $3500 per acre within the grading construction limits, excluding the roadbed areas where clearing and grubbing operations expose soils to erosion. The Engineer will determine the areas open to erosion before approving each partial estimate. Release erodible area withholdings per table 2574-5.

A.2 Temporary Grading

Shape embankment to remove clods of soil greater than 3 inches diameter and ruts, erosion rills, or washouts deeper than 3 in prior to installing temporary erosion control materials in locations where the final grading grade has not been established.

A.3 Soil Tracking

Perform soil tracking on embankments to create horizontal grooves on an exposed slope using a stair-stepping backhoe bucket procedure or run tracked construction equipment up and down the slope. Perform the stair-stepping procedure parallel to the contour of the land.

Perform subsoil tracking on slopes steeper that 1:2 (V:H) to scarify the surface per 2106.3.G "Finishing Operations" or for temporary grading operations.

Perform topsoil tracking on topsoil for slopes steeper than 1:2(V:H) when placing topsoil in those areas.

A.4 Soil Bed Preparation

Prepare the soil surface to provide a smooth, moist, and evenly textured foundation before sowing seed or placing sod. Complete the tilling after applying soil amendments to the soil. Use cultivating equipment such as disks, harrows, field diggers, or tillers capable of loosening the soil to a depth of at least 3 in. on all areas except for slopes steeper than 1:2 (V:H). Till the soil surface to remove track imprints from wheeled or tracked equipment. Operate cultivating equipment on slopes at right angles to the direction of surface drainage. Soil clods, lumps, and tillage ridges 3 in. high or less may remain in place for seeding operations. Soil clods, lumps and tillage ridges 1.5 in. high may remain in place for sodding operations. Multiple passes of the equipment may be needed to meet these requirements.

A.5 Subsoiling

Deep rip soils before placing topsoil on areas where topsoil placement depth is greater than 6 in. otherwise after topsoil is placed in the following areas:

- Where the subsoil has been compacted by equipment operations, and
- Staging areas, old road beds to be vegetated.

Subsoil infiltration basins before placing topsoil borrow Type G per 3877, "Topsoil Borrow."

Deep rip soil in in one direction on the contours perpendicular to the flow of water or as shown in the plans. Use a multi-shanked, parallelogram or single tooth implement to create channels. Do not use disc cultivators, chisel plows, or spring-loaded equipment to perform subsoiling. Space channels from 12 in. to 36 in. apart except as shown on the plans. Create channels to provide a depth from 16 in. to 20 in. or as shown on the plans. . For saturated soil, delay subsoiling operations until soil dries to at least field capacity.

Observe a minimum setback as directed by the Engineer for the following subsoiling exceptions:

- Areas within the dripline of existing trees,
- Over utilities,
- Where trenching or drainage lines are installed,
- Where compaction is required by design (abutments, footings, or inslopes), and
- Inaccessible slopes.

B Infiltration, Filtration, and Bioretention Areas

Construct sites after stabilizing contributing drainage areas. Stabilize areas draining to infiltration sites. Prevent sediment laden runoff from entering infiltration site during construction. Use light tracked equipment to excavate, grade, shape, and place soil loosely as shown on the plans. Minimize tracking and compacting over the infiltration areas. Prevent excavated material from re-entering the basin during the work.

C Topsoil

Place and shape topsoil to the depths as shown on the plans. Remove all rocks and debris exceeding 3 in. on topsoil surface.

Salvaged Topsoil Excavation Material per 2105 "Excavation and Embankment," shall be stockpiled on the project site or at a suitable location approved by the Engineer. Test stockpiled topsoil in accordance with the testing procedures for soil fertility in 3877, "Topsoil Borrow." Complete the testing at least 1 month before placement. Use these test results to determine pH adjustments and fertilizer, soil additives, and compost needs for plant establishment. The Engineer will determine adjustments to the existing topsoil for plant establishment based on the test results.

Topsoil Material sources must be approved by the Engineer prior to blending and delivery. Before blending individual components to create a topsoil borrow, verify that each component meets the specification requirements.

D Applying Soil Amendments

Do not place commercial fertilizer, liming material, and soil additives on frozen ground or snow. Apply fertilizers after the runoff from spring snowmelt.

Use mechanical spreading devices to uniformly apply fertilizers, compost, liming materials, and additives at the rates required by the contract before placing seed or sod. Till the soil at least once within 24 hours of placing fertilizer, compost, lime, or soil additives. Apply seed within 48 hours of fertilizing.

The Department based the lime application rates on 1,000 lb Effective Neutralizing Power (ENP) per ton of agricultural liming material. Adjust the actual lime application rate to meet the above rate.

The Contractor may use Grade 1 compost instead of commercial fertilizer, as approved by the Engineer. Apply the compost at an equivalent nutrient application rate to the rate for commercial fertilizer shown on the plans.

E Acceptance of Work

Notify the Engineer at least 24 hours before beginning and changing soil preparation operations. Till soil amendments into the soil before seeding operations. The Engineer will reject soil preparation not verified by inspection as unauthorized work per 1512, "Unacceptable and Unauthorized Work."

The Engineer will accept filter topsoil when placed in infiltration, filtration, or bioretention areas after an infiltration test demonstrates an acceptable infiltration rate per 3877, "Topsoil Borrow."

F Workmanship and Quality

The Engineer may require corrective action for the conditions not meeting contract requirements to qualify for payment. Perform corrective actions when the quality and workmanship fails to meet the material, installation, maintenance or removal requirements.

2575.1 DESCRIPTION

This work consists of applying temporary soil covers and establishing a perennial ground cover to reduce the risk of soil erosion.

Temporary soil covers include mulch, establishment of an annual vegetative cover, erosion control blanket and hydraulic soil stabilizers. Establishment of a perennial vegetative cover includes seeding, sodding, mulching, and any other specified work.

2575.2 MATERIALS

2575.3 CONSTRUCTION REQUIREMENTS

A General

Minimize soil erosion and prevent damage from sedimentation by using the Best Management Practices (BMP) to cover bare soils in temporary and permanent conditions. Use temporary erosion control BMP's, including limiting the amount of exposed erodible soils and providing for proper exposed soil stabilization for slopes, ditches, storm drain and culvert outlets, and storm water discharge points from erosion. Use permanent erosion control BMP's to provide the final stabilization of exposed slopes. Properly prepare soils in accordance to 2574, "Soil Preparation."

A.1 Exposed Soil Stabilization

Stabilize areas of exposed soils that are larger than 2 acres in size using temporary seed mixtures and erosion control products. Use rapid stabilization methods to temporarily stabilize contiguous areas of exposed soil that are less than two acres in size and are:

- Within 200 feet of a surface water
- Within 200 feet of Areas of Environmental Sensitivity (AES)
- Required by the contract

Schedule, construct, or install stabilization measures on exposed soil areas as shown on the plans or as required by the contract.

A.2 Growing Seasons

Schedule and install temporary and permanent seed or sod in areas at the optimum growing time for proper turf establishment

A.2.a Seeding Dates

Plant seed mixtures during the seasons of planting for the various seed mixtures in accordance with Table 2575-1:

Table 2575-1
Season of Planting

Seed Mixture Number	Spring	Fall
21-112	—	Aug. 1 – Oct. 1
21-111	May 1 – Aug. 1	—
22-111, 22-112*	April 1 – July 20.	July 20 – Oct. 20
25-121, 25-131, 25-141, 25-151*	April 1 – June 1	July 20 – Sept. 20
25-142*	April 1 – Sept. 1	—
Any mix beginning with a 3	April 15 – July 20	Sept. 20 – Oct. 20

* For the portion of Minnesota north of, and including T.H. 2, plant seed mixtures 22-111 to 25-142 from April 15 to September 20.

Provide temporary stabilization when outside the season of planting dates of the specified permanent seed mixture

Request to adjust dates in writing by no more than 10 calendar days to shorten or extend the exclusion dates when conditions warrant. The engineer may approve the request or direct the contractor to seed outside the seeding dates.

A.2b Sodding Dates

Sod growing days are any calendar day between April 15 and November 1. Avoid installing Lawn and Mineral sod between June 10 and August 10. Avoid installing Salt tolerant Sod between June 10 and November 1.-The engineer may adjust these dates to shorten the excluded periods when conditions are favorable to active growth, or to lengthen the excluded period when conditions for establishment are unfavorable.

Provide temporary stabilization when outside the sodding dates.

A.3 Winter Season

During the winter season, perform erosion control operations to protect the site through the end of the spring snowmelt season. Such practices include dormant seeding and sodding, snow seeding and mulching, and frozen ground mulching. Both dormant seeding and sodding are performed during the period when soil temperatures will not allow seeds to germinate and when normal plant rooting will not occur.

A.4 Substitutions

The Engineer may allow substitutions in accordance with 1605, "Substitute Materials" for the following products; Mulch, Erosion Control Blankets, Turf Reinforcement Mats, and Hydraulic Erosion Control Products. The Engineer, in consultation with Office of Environmental Stewardship Erosion Control and Storm Water Management Unit, may authorize requested substitutions. Provide substitutions equal to or better than initially specified material.

B Placing Seed

Store the seed from time of purchase until installation at 50° F and 50 percent humidity. Protect the seed from moisture until sowing. Do not use wet or moldy seed. Apply seed within 48 hours of fertilizer application.

Sow the seed uniformly at the adjusted bulk rate of application for each mixture. Adjust the bulk seeding rate needed to achieve the required PLS rate for the mixture in accordance with 3876, "Seed" and the following formulas:

(1) Bulk Application, lb. = $\frac{PLS, lb}{\%PLS}$

(2) % PLS = % germination × % purity

Immediately after seeding firm the seedbed with a cultipacker to provide seed to soil contact. Do not broadcast seed with wind velocities greater than 15 mph.

B.1 Temporary Seeding

Perform temporary seeding in addition to temporary mulching on graded areas with topsoil and unable to receive permanent seeding or slopes and topsoil berms left idle for longer than 21 days. Use cover crop and mid-term stabilization seed mixtures as shown in 3876, "Seed", Table 3876-1 for temporary seeding.

Prepare the soil in accordance with 2574.3.A and 2574.3.B, except for stockpile and berms where no soil preparation is needed.

B.2 Seeding Turf Mixes

Mechanically sow or hydraulically apply non-native seed mixes (any mix beginning with a number 2) uniformly at the adjusted bulk application rate of each mixture. Only use hand operated mechanical spreaders on areas too small for or inaccessible by the specified equipment.

If using an agricultural type seed drill, operate the drill in a general direction at right angles to the direction of surface drainage and sow the seed shall to a depth no greater than ⅜ in.

B.3 Seeding Native Mixes

Seed native mixes (any mix beginning with a number 3) with a native seed drill, a drop type seeder, or a hydro seeder uniformly at the adjusted bulk application rate of each mixture. Use a drill capable of accurately metering the types of seed planted and capable of maintaining a uniform mixture of seeds during drilling. Use a drill with disk furrow openers and a packer assembly to compact the soil directly over the drill row. Seed native mixes in rows spaced no greater than 8 in. apart. Place seeds to a final planting depth from ⅛ in. to ⅜ in. Perform drill seeding at a right angle to surface drainage. A drop type seeder equipped with a separate seed box for the fluffy seed and a soil packer assembly may be used in lieu of a drill with disc openers. Use a cyclone or spinner type seeder on areas no greater than 1 acre or on areas inaccessible to other equipment, as approved by the Engineer.

B.4 Hydro-seeding

Use a hydro-seeder capable of continuous agitation action to uniformly distribute the seed at the adjusted bulk application rate of each mixture. Add a 50 lb. of Type Hydraulic Mulch per 3884, "Mulch Material," as a tracer for each 500 gal. of water in the hydro-seeder tank. Use flood type nozzles and Manufactures' recommended water volume.

Once the seed has been added to the tank mixture a one hour time limit is set for spreading the mixture on the soil. Once the one hour is passed the excess mixture must be discarded.

Perform hydro-seeding separate from placing Hydraulic Erosion Control Products (hydro-mulching).

B.5 Interseeding

Perform interseeding if seeding into temporarily mulched areas or if drilling additional seed into previously seeded areas. Use an interseeding drill containing trash rippers and at least one box for fine seed and one box for larger seeds or fluffy seeds. Operate the drill to slice through the thatch layer and make a furrow 1 in. wide and from ⅜ in. to 1 in. deep in the underlying soil. Place seeds in the furrows through the drill seed disk openings. Drop the seed onto the ground surface from the fine seed box. Place the large or fluffy seed to a final planting depth from ¼ in. to ⅜ in.

B.6 Permanent Seeding into Temporarily Mulched/Blanketed Areas

Permanently seed areas previously temporarily mulched. Without performing additional tillage or site prep work, the Contractor may use an interseeding drill to drill seed directly into temporarily mulched or temporarily seeded areas. In lieu of using an interseeding drill, the Contractor may lightly disc the mulched areas before seeding. Apply fertilizer within 24 hours before interseeding or light disking. Leave the existing cover in place as serve as mulch.

Permanently seed into areas temporary blanketed using the hydroseeding application as mentioned above. Hydroseed into the installed blanket with the nozzle 6 ft. from blanket, forcing the seed and water through the blanket.

B.7 Winter Seeding

Dormant seed after the fall seeding date and when soil temperatures 1 in. below surface are no greater than 40 °F.

Perform snow seeding over the top of snow allowing the seed to melt through the snow to the soil and germinate upon warm up in the spring.

C Applying Mulch

Mechanically spread mulch to provide a uniform distribution over all exposed soil at the application rate to provide 90 percent uniform soil coverage. If non-uniform distribution occurs, re-mulch areas or remove the excess coverage.

Do not operate mulch-blowing equipment on slopes steeper than 1:2.5 (V:H) or on slopes that will rut the soil surface. Use blower attachments to apply the mulch without traversing the slopes. Do not mulch with wind velocities greater than 15 mph.

Areas within 10 ft. of the shoulder immediately mulch, and anchor the mulch in a continuous operation after seeding. If traffic or wind dislodges the seed or mulch due to delays in the continuous operation, reseed and re-mulch the affected areas.

Areas outside 10 ft. of the shoulder shall be mulched within 24 hours after seeding.

C.1 Temporary Mulching

Perform temporary mulching on contiguous areas of 2.0 acres and greater to protect the site from erosion when left idle for more than one week and during non-seeding periods and when outside the seeding and sodding dates. For areas less than two acres, mulch in accordance with 2575.3.M, "Rapid Stabilization."

C.2 Type 1, Type 3, Type 7, and Type 8 Mulch

Use blower equipment to place Type 1, Type 3, Type 7, and Type 8 mulch at a target application rate of 2 ton per acre. Apply the mulch at an actual rate as directed by the Engineer to match varying material or project conditions. Apply the mulch to ensure 90 percent coverage of the soil surface.

C.3 Type 4 Mulch

Apply Type 4 mulch as a dual operation with the Type 1 mulch blown on the soil surface at 1 ½ tons per acre and immediately over-spray with 3884, Stabilized Fiber Matrix at 750 lbs. per acre.

C.4 Type 5 Mulch

Apply Type 5 mulch at a rate of 80 cu. yd. per acre as specified in the plans as an erosion control material.

C.5 Type 6 Mulch

Apply Type 6 mulch at the rate shown on the plans or special provisions.

C.6 Type 9 Mulch

Apply Type 9 mulch at a rate required by the contract. Before placing mulch, uniformly compact and smooth the foundation, cover the foundation with Type 1 geotextile, per 3733, "Geotextiles," and uniformly spread the aggregate mulch to the thickness shown on the plans without harming the foundation. Level the finished aggregate surface flush with adjacent areas.

C.7 Winter Mulching

Perform frozen ground mulching on bare frozen soils. Place 3882, Type 5, Type 6, and Type 9 mulch materials with no modifications to meet the requirements of frozen ground mulching. Place 3882, Type 1, Type 3, or Type 8 mulch materials with the following modifications to meet frozen ground mulching:

At temperatures above 20 °F use 3884, Type Natural or Synthetic Tackifier, in lieu of disc anchoring

At temperatures below 20 °F delay mulching until ground is snow covered and perform snow mulching.

Perform snow mulching at any time over the top of snow. No disc anchoring is required. Apply Snow mulching prior to or during a snowfall event.

D Disk Anchoring

Anchor Type 1, Type 3, and Type 8 mulches with a disk anchoring tool as required by the contract immediately after placement unless otherwise approved by the Engineer.

Punch the mulch into the soil to a depth from 2 in. to 3 in.. Space the blades and discs on the anchoring tool no greater than 8 in. apart. Use Hydraulic Erosion Control Products to anchor the mulch in lieu of disc anchoring, in areas inaccessible by disc equipment.

E Placing Hydraulic Erosion Control Products

Protect public and private investments and properties from overspray by suitable means and methods including appropriate shields, covers and avoidance measures. Accidental overspray must be cleaned up at the time of installation (occurrence). Perform after and separate from hydro-seeding. Provide an Applicator's Certification from the manufacturer before applying the Polyacrylamide Tackifier, Organic Fiber Matrix, Bonded Fiber Matrix, and Reinforced Fiber Matrix.

E.1 Tackifiers

Use natural tackifiers alone, as an additive to other soil stabilizers, or as an overspray on mulched areas.

E.1.a Type Natural Tackifier

Use the manufacturer's recommended rate of application and mix ratios based on use, site conditions, and time of year. Allow from 9 to 12 hours of dry time before subject to rain. Uniformly distribute the tackifier over the target area.

E.1.b Type Synthetic Tackifier

Dilute synthetic tackifier at a rate of 10 parts water to 1 part polymer and apply to the soil at a rate of 1,200 gal per acre.

E.1.c Type Polyacrylamide (PAM)

Do not use polyacrylamide (PAM) on pure sand or gravel without fine silts or clays. Do not apply PAM over snow cover or to slopes that flow directly into a wetland or state waters. Apply PAM as recommended by the manufacturer.

Provide certification of the following:

(1) Percent of pure PAM present by weight,
(2) Percent activity,
(3) Average molecular weight, and
(4) Charge density of the PAM.

Provide a material safety data sheet for prepackaged PAM. The Contractor may include PAM as a part of a polymer stabilized fiber matrix. Apply PAM in its pure form on slopes and channels at a rate no greater than 200 lb. per acre and no later than 4 hours prior to rain.

E.2 Matrices

E.2.a Type Organic Fiber Matrix (OFM)

Apply organic fiber matrix with hydraulic spray equipment in a water-slurry mixture. The tank must have jet or mechanical agitation for mixing. The dry material targeted application rate is 3,500lb per acre. Use the water to bale ratio as recommended by the manufacturer.

E.2.b Type Mulch

Apply hydraulic mulch with hydraulic spray equipment in a water-slurry mixture. The dry material targeted application rate is 2500 lb. per acre. Use the water to bale ratio as recommended by the manufacturer. Increase the application rate and percent tackifier to roughened soils for complete coverage. The Engineer may inspect the tank loading and spray application, to verify that the applied materials meet the manufacturer recommendations and the soil is 100 percent covered.

E.2.c Type Stabilized Fiber Matrix

Do not field mix additives or components for stabilized fiber matrix, as this mulch is a pre-manufactured matrix. Apply stabilized fiber matrix at the targeted dry weight rate of 3000 lb. per acre. Adjustments made in the field based on site characteristics, soil conditions, and manufacturer recommendations.

E.2.d Type Bonded Fiber Matrix (BFM)

Apply BFM with hydraulic spray equipment by a manufacturer's certified applicator. The Contractor may apply seed and BFM in a single operation in small or inaccessible areas as approved by the Engineer. Apply BFM at the targeted dry weight rate of 3500 lbs. per acre. Adjustments are made in the field based on site characteristics, soil conditions, and manufacturer recommendations. Use the water to bale ratio recommended by the manufacturer. Apply the BFM from at least two opposing directions and obtain continuous ground coverage. Apply the BFM in two stages using one half of the material in each stage. Allow the first stage application to dewater before applying the second stage. Do not use BFM in water bearing soils or by itself in ditch bottoms carrying concentrated flows.

E.2.e Type Reinforced Fiber Matrix (RFM)

Apply FRM with hydraulic spray equipment by a manufacturer's certified applicator. Apply RFM at the targeted dry weight rate of 3,900 lb. per acre. Adjustments made in the field based on site characteristics, soil conditions, and manufacturer recommendations. Use the water to bale ratio recommended by the manufacturer.

F Placing Sod

Before delivering sod to the work site, prepare the soil per 2574.3.A, to avoid delays in placing the sod. Before placing the sod pre-wet the soil to a damp condition. Provide proper notching into existing surfaces. Hand tamp or roll sod to get complete ground contact.

Use straw or hydro mulch to stabilize exposed areas until installation of sod is within the specified sodding dates. Incorporate any straw mulch into soil prior to sod installation.

Reseed or remulch damaged areas adjacent to the sod within 5 working days after completing the sod placement and rolling or tamping operations.

F.1 Slopes

Place sod strips starting at the bottom of the slope and progressing upward with long edges parallel to the contour. Stagger joints alternately without space between. Secure the sod to the slope with wire staples or another anchor system approved by the Engineer as per Table 3885-5 spaced no greater than 2 ft. apart. At the tops of slopes steeper than 1:4 (V:H), trench the sod 3 in. into the topsoil.

Shingle sod on slopes 1:2 (V:H) and steeper and at culvert ends, overlap the upper piece by at least 3 in.. Use wire staples to secure sod on the slope at 16 in. intervals. Trench 3 in. of sod into the topsoil on the uppermost strip of sod.

F.2 Ditches

In ditch bottoms and other areas with expected concentrated water flow (i.e. flumes), place the sod parallel to the direction of water flow in the main channel. Shingle sod overlapping the ends by at least 4 in. and the edges by at least 3 inches. Trench 3 in. of sod into the topsoil on the uppermost strip of sod on side-slopes steeper than 1:4 (V:H).

In ditch bottoms with high flow velocities, overlay shingled sod with jute, a biodegradable netting, or chain link fence. Use stakes or staples to secure the jute, netting, or fence to the sod. The jute, biodegradable netting, or the chain link fence will not require removal after maintenance period.

F.3 Dormant Sodding

Dormant sod on slopes, in ditches, and at least 10 ft. from the shoulder after the fall sodding date and soil freeze-up meeting the following conditions:

(1) The Engineer authorizes dormant sodding,
(2) Provide Soil Preparation for sod,
(3) Stake or staple the sod on slopes and in ditches,
(4) Water the sod to saturation immediately after placement, and
(5) Water the sod a second time from 7 to 10 calendar days after placement. The second watering is not needed when the sod receives 1 in. of rain or snow cover.

Do not dormant sod in areas shown with Salt Tolerant Sod (3878) or within 10 ft. from the shoulder, including areas next to boulevards and areas receiving salt encrusted snow and ice from winter deicing operations. Temporary stabilize these areas with mulch or Erosion Control Blanket.

G Placing Rolled Erosion Control Products

G.1 Blank

G.2 Erosion Control Blankets

Place the blankets within 24 hours after sowing of the seed on that area. Blankets with netting on two sides, place the side of the blanket with the majority of thread stitching on the bottom. Roll out blankets flat and parallel or perpendicular to the direction of water flow. Evenly spread the blankets without stretching, allowing the fibers to come in direct contact with the soil over the entire area. Shingle and overlap the edges parallel to water flow by at least 4 in.. Shingle and overlap the edges perpendicular to water flow by at least 7 in. Staple overlaps on slopes at 1½ ft. intervals, see Table 3885-5.

At the tops of slopes and at the beginning of each blanket in ditch bottoms, bury the upgrade end of the blanket in a check slot 6 in. wide by 6 in. deep. Insert the blanket end to the full depth of the check slot. Backfill and compact the check slot. For slopes longer than 100 ft., dig a second check slot perpendicular to the slope gradient one-third of the slope length measured from the bottom of the slope. Place the blanket to the full depth of the check slot. Backfill, and compact the check slot. Staple blankets with the number of staples in accordance with Table 2575-2 or in accordance with manufacturer recommendations:

Table 2575-2
Stapling of Blankets

Slope (V:H)	Minimum Number of Staples per 100 *sq. yd*
Flatter than 1:2	120
1:2 – 1:1	170
Channel or ditch applications	350

G.3 Placing Turf Reinforcement Mats

Shape and prepare the site by in accordance to 2574. Provide turf reinforcement mat meeting the requirements of the class as shown on the plans. Soil fill turf reinforcement mats.

Place ½ the seed, fertilizer, and topsoil under the TRM and the other ½ on top. Install the mat, seed, fertilizer, topsoil, and Category 3 erosion control blanket in one continuous operation. Roll out or lay the mat parallel to the direction of water flow. Evenly spread the mat without stretching, allowing the fibers to come in direct contact with the soil over the entire area. Bury and staple the beginning edge of each mat in a check slot 6 in. wide by 6 in. deep. Overlap adjacent strip edges by at least 4 in.. Staple the mat to provide 3.5 staples per sq. yd.

Directly seed and fertilize with the amounts as shown on the plans. Soil fill with Sand Clay Loam Topsoil per 3877 "Topsoil Borrow," or as an alternative Grade 2 compost per 3890, "Compost," to a depth from ½ in. to 1 in. If equipment must operate on the mat use only rubber tired type. No tracked equipment or sharp turns are allowed on the mat. Smooth out soil to just expose the top netting of the matrix. Install Category 3 erosion control blanket per 2575.3.G.2, on top of the seeded topsoil.

For Steep slopes, 2:1 or greater hydraulically fill the cells of the TRM with seed and fertilize and mulch and tackifier into the mat with Reinforced Fiber Matrix (3884) at a rate of 3500 lbs/ac or to just fill the TRM cells, but not over fill.

G.4 Winter Installation

Install 3885, erosion control blankets over frozen ground and use the appropriate anchors in as shown in Table 3885-5.

G.5 Placing Flexible Concrete Geogrid Mat

Shape and prepare the site in accordance to 2574, "Soil Preparation" or as shown in the plan.

Furnish and install Flexible Concrete Geogrid Mat at the locations specified on the plans according to the standard specifications, the manufacturer's installation guidelines and in accordance with 3870. Prepare the subgrade as smooth and free of all rocks, stones, sticks, roots, other protrusions, or debris of any kind. The prepared surface shall provide a firm unyielding foundation for the mats with no sharp or abrupt changes or breaks in the grade. Apply seed directly to the prepared soil prior to installation of the Flexible Concrete Geogrid Mat. Install Flexible Concrete Geogrid Mat to the line and grade shown on the plans and according to the manufacturer's installation guidelines for head and side trenching, shingle overlap, and rebar anchoring spacing.

G.6 Placing Concrete Fabric Mat

Provide concrete fabric mat at the thickness shown in the plans. Shape and prepare soil for concrete fabric mat. At the edges of the mat, bury the upgrade end of the mat in a check slot 6 in wide by 6 in deep. Install anchoring pins at 2 to 3 ft spacing along the edges and seams. Overlap all edges by at least 4 in and secure with anchoring pins. Apply a bonding seal agent to the seams for a water tight seal. Apply sufficient water to allow proper saturation and hydration and setting of mat and cover as per manufacture recommendations. Apply additional water 1 hour later on fabrics thicker than 0.5 inches, ditch grades greater than 2 percent, slopes greater than 1:3, and temperatures greater than 80 degrees Fahrenheit to complete the hydration process. Concrete Fabric Mat has a working time of 1-2 hours after hydration.

H Shoulder Mulch Overspray

Perform shoulder mulch overspray by spraying 3884, Tackifier over seeded and mulched areas on a strip 3 ft. wide immediately abutting a gravel or paved shoulder as shown on the plans. During placement, perform the following:

(1) Seed,
(2) Cultipack the seedbed,
(3) Place Type 1 mulch,
(4) Immediately disk anchor the mulch as required by the contract, and
(5) Uniformly overspray with Type natural Tackifier as a continuous operation.

Use a distributer spray bar to spray the 3884.2.A, "Tackifiers", at an application rate of 200 lbs. per acre that provides 90 percent ground coverage.

I Compost Blanket

Uniformly apply a 2 in. deep layer of Grade 2 compost per 3890, "Compost," as a compost blanket over the soil after preparing the soil per 2574, "Soil Preparation". Distribute the compost by hand with a shovel, spreader unit, or pneumatic blower. Incorporate seed into the compost or broadcast the seed over the top after uniformly spreading the compost. When placing compost blanket adjacent other erosion control products or existing vegetation provide an overlap of at least 2 ft.. When placing compost blanket on a 1:2 (V:H) slope, place and anchor open weave textile netting over the top.

J Weed Control

Control and prevent the spreading of state listed Noxious Weed (NW) and/ or invasive weeds as per contract or as directed by the Engineer. The current state listed NW species is determined by the Minnesota Department of Agriculture. Identify, mark, map, and monitor weed infestation areas and apply treatments at the appropriate time in order to prevent seed production and spreading.

Obtain a permit from the County Agricultural Inspector or Minnesota Department of Agriculture to transport material or equipment containing propagating parts of NW. Follow the permit requirements. Submit to Engineer a copy of the permit.

Submit a plan for reducing the spread of NW at pre-construction meeting. The Plan must include methods and sequence of work. Plans including the use of herbicide(s), submit a copy of the Commercial Applicator License with categories for CORE and Rights-of-Way and list of herbicides to be used. The Inspector must approve herbicides used on MnDOT right-of-way prior to use.

Movement and reuse of topsoil from infested areas shall be limited to the confines of identified infested areas.

Delineate weed infested areas indicated on the Plan on the Project and when appropriate, fence off from any work, vehicles, or equipment.

Minimize the spread of weed seed and other propagules from designated infested areas by minimizing disturbance and by cleaning vehicles and equipment. Cleaning shall remove soil and vegetation debris from vehicles and equipment before moving out of infested areas or moving into project limits. Stockpile of NW infested soils shall be separate from non-infested stockpiles.

K Maintenance

K.1 Sod

Sod maintenance period is 30 calendar days. The maintenance period is suspended when soil temperature falls below 32 degrees Fahrenheit and resumes after snow melt and soil temperature is above 40 degrees Fahrenheit. Water within ½ hour after sod is laid on soil and provide 1 in. of water. Water sod as needed to maintain soil moisture for the first 10 calendar days. For the remainder of the 30 calendar days, water sod to supplement rainfall to provide 1 in. per week. Apply all water at a rate that prevents runoff to occur.

During the maintenance period, replace sod dried, dead, damaged, displaced, or weakened or sod infested with over 50 percent weeds. Maintain areas replaced with new sod for at least 20 calendar days after replacement.

After maintenance period has ended and as directed by the Engineer apply additional water to supplement rainfall not to exceed 1 in. per week until soil temperature falls below 32 degrees.

K.2 Rolled Erosion Control Products

Maintain the erosion control blanket installation for 45 calendar days if required by the contract or if substituting erosion control blankets and seed for sod, as approved by the Engineer. Maintain turf reinforcement mats for 45 calendar days, if required by the Contract. Water the blankets and mat systems immediately after placement at a rate of at least 3,000 gal. per acre and appropriately to establish vegetation. Control erosion and establish a permanent vegetative cover as approved by the Engineer until contract acceptance. Restore areas with seeding failure or erosion during the maintenance period at no additional cost to the Department.

K.3 Seed

Repair damage within the area caused by Contractor operations and within the Contractor's control at no expense to the Department. Reseed areas where the original seed has failed to grow, as directed by the Engineer.

K.4 Mulch

Re-mulch areas where the original mulch has eroded, washed away, or blown off, and reseed areas where the original seed has failed to grow, as directed by the Engineer. Use the seed mixture shown on the plans or other seed mixture approved by the Engineer to perform reseeding.

K.5 Mowing and Weed Spraying

Perform the work required to control the Department of Agriculture State listed Prohibited Noxious Weeds, either on the areas seeded or sodded under the Contract. The weed spray mixture to be furnished and used shall be as required for that weed control. The engineer shall approve all work and weed control material prior to the start of work. The equipment used shall not be so heavy that it causes soil slips or ruts on the slopes or in the ditches. Perform the work at such time and in such a manner that will avoid spray drift outside the areas designated for spraying

L Turf Establishment

Turf Establishment by a lump sum is for establishing permanent vegetation on small areas of 2 ½ acres or less per Contract. Such work shall include; soil bed preparation, fertilizer, sod or mulch, blanket, seed and repair of erosion rills of 3 in. or greater in width or depth.

Unless otherwise shown on the plans, establish vegetative cover by sodding or by seeding and mulching. Fertilize the areas with a Type 3, slow release fertilizer in accordance with 3881.2.B3 at a rate derived from a topsoil fertility test. If seeding, provide and place seed Mixture 25-141 as specified in 3876, "Seed", and provide 3882, Type 3 mulch with disc anchoring or Category 3 Erosion Control Blanket on slopes 1:3 and steeper, and ditch bottoms.

The Engineer will accept the area after the perennial seed germinates, vegetation is at least 4 inches in height, and cover is uniform. If the seeding fails to germinate, correct and reseed failed areas to establish turf. If using sod, place and maintain sod in accordance with 2575.3 F and K. The Engineer will accept sod in accordance with 2575.3.N.

L.1 Subsurface Drain Outlets

As per 2502,"Subsurface Drains," place seed mixture 25-141 in accordance with 3876, "Seed", or the seed mixture as shown in the plans. Place Category 3 erosion control blanket, per 3885, "Rolled Erosion Control Products," or as shown in the plans, for that area. Center the headwall along the width of the blanket. Extend the blanket 3 ft. above the headwall, and 6½ ft. below the headwall or to the toe of slope, whichever is the shorter distance. Place anchor staples at intervals no greater than 1½ ft. apart. If placing a headwall at a location that will be sodded as required by the contract, delete the seed and erosion control blanket.

M Rapid Stabilization

Perform rapid stabilization at any time when work is stopped temporarily and there is a risk that sediment will enter the resource waters due to stormwater runoff. Provide the materials for the methods of rapid stabilization in accordance with Table 2575-3:

Table 2575-3
Rapid Stabilization

Method	Materials
1	Type 1 mulch placed at a rate of 2 ton per acre with disc anchoring.
2	Type 3 mulch placed at a rate of 1.5 ton per acre. 3884, Stabilized Fiber Matrix, placed at a rate of 750 lb per acre.
3	3884, Stabilized Fiber Matrix, placed at 330 lb. per 1000 gal. of slurry mix. Seed mixture 22-111 placed at a rate of 10 lb. per 1,000 gal. of slurry mix. Type 3 Slow Release Fertilizer 10-10-10 placed at a rate of 50 lb. per 1000 gal. of slurry mix. Water placed at a rate of 875 gal per 1,000 gal of slurry mix. Apply mixture at a rate of 6000 gal per acre.
4	Category 3 erosion control blanket. (natural net if required in plan for permanent blanket) Seed mixture 22-111 placed at a rate of 2 lb. per 100 sq. yd. Type 3 Slow Release Fertilizer 10-10-10 placed at a rate of 8 lb. per 100 sq. yd.
5	Rip Rap Class II. Geotextile Type III.

M.1 Placement

M.1.a Method 1

Use Method 1 to place mulch on a coverage area from ½ acre to 2 acre. Loosen the soil surface before placement to allow anchoring the mulch. Place the mulch to obtain 90 percent ground coverage. Use blower equipment to place mulch. In areas inaccessible to a blower, place mulch by hand. Immediately after placement, use a disc anchoring tool to anchor the mulch.

M.1.b Method 2

Use Method 2 to place mulch on a coverage area from ½ acre to 2 acre. Loosen the soil surface before placing the mulch. Place mulch to obtain 75 percent ground coverage. Use blower equipment to place mulch. In areas inaccessible to a blower, place mulch by hand. Immediately after placement, overspray the mulch with Type Hydraulic Mulch, at a rate of 750 lb. per acre.

M.1.c Method 3

Use Method 3 to place slurry on a coverage area from ½ acre to 1.5 acres. Apply material in quantities to obtain 100 percent soil surface coverage. In inaccessible areas, pump the mix through a hose. Do not place on snow covered areas. Do not use when material is left in the tank overnight.

M.1.d Method 4

Use Method 4 to place fertilizer, seed, and erosion control blanket on a coverage area from 100 sq. yd. to 800 sq. yd. Bury the upgrade end of each blanket strip at least 6 in. in a vertical check slot. Place staples at seams and throughout the blanket spaced no greater than 2 ft. apart.

M.1.e Method 5

Use Method 5 to place class II riprap and geotextile to cover areas.

N Acceptance of Work

Notify the Engineer at least 24 hours before beginning or changing turf establishment operations.

N.1 Seeding

The Engineer will accept permanent seeding in area increments after the placement of seed in accordance with the specifications 2575.3B. For hydro-seeding acceptance will be based on uniform soil coverage.

N.2 Mulching

Mulching will be accepted 2 calendar days after initial placement. Re-mulch areas where the mulch has blown off or washed away during the 2 calendar day period at no additional cost to the Department.

N.3 Sod

After expiration of the sod maintenance period, the Engineer will inspect the work and will accept living sod that is placed in accordance with 2575.3F.and when pulled does not lift from soil.

N.4 Erosion Control Blankets and Turf Reinforcement Mats

For contracts not requiring maintenance, the Engineer will accept blankets and mulch control netting and mats when installed in accordance to 2575.3.

N.5 Hydraulic Erosion Control Products

The Engineer will accept hydraulic erosion control products providing 90 percent exposed soil coverage. The Engineer will accept areas covered by BFM and Type RFM at 100 percent exposed soil coverage.

O Restoration

After the Engineer accepts the turf establishment in an area, restore areas damaged by erosion and sedimentation beyond the Contractor's control as directed by the Engineer. Scarify, grade, shape, excavate, and till to restore eroded areas and clean up sedimentation as directed by the Engineer. Shape, fill, and compact depressions and washouts resulting from erosion with suitable topsoil borrow meeting 3877, "Topsoil Borrow," as approved by the Engineer. Remove deposited sedimentation as directed by the Engineer. Spread or dispose of sediment removed as approved by the Engineer.

Use seed, mulch, erosion blankets, and sod in the restoration as approved by the Engineer.

P Temporary Poly or Geotextile Coverings

Cover exposed soils with poly sheeting, or Type 5 Geotextile fabric and secure tightly in place using an anchoring system of sand bags or other methods accepted by the engineer. Trench at the top of slope and secure adequately to maintain cover during reasonably expected conditions in the area. Provide a water diversion above to direct water away from areas and prevent undermining. Provide toe protection to control drainage from areas covered so that the discharge does not cause erosion.

Q Workmanship and Quality

To qualify for payment, perform corrective actions when the quality and workmanship fails to meet the material, installation, or maintenance requirements in the contract.

3248 POLYVINYL CHLORIDE PIPE

3248.1 SCOPE

Provide polyvinyl chloride (PVC) pipe for use as culverts or pipe sewers.

3248.2 REQUIREMENTS

Provide PVC pipe with couplings and fittings meeting the requirements of the following:

(1) AASHTO M 304; and
(2) ASTM F 949; and
(3) Section 12 of the AASHTO LRFD Bridge Design Specifications.

Provide polyvinyl chloride (PVC) pipe with a watertight seal that shows no sign of leakage when tested in accordance with ASTM D 3212. Elastomeric seals (gaskets) used for joining pipes must meet ASTM F 477.

Submit a laboratory certification that the pipe connection for each size pipe meets or exceeds the requirements in this section.

Submit the shop drawings of each pipe coupler provided by the pipe manufacturer and any additional mechanical connections as required by the plans.

Provide polyvinyl chloride (PVC) pipe and fittings manufactured from virgin PVC compounds. May use clean, reworked PVC materials from the manufacturer's own production if the pipe and fittings meet the requirements of this section.

Store and handle corrugated polyvinyl chloride (PVC) pipe as recommended by the manufacturer. Provide polyvinyl chloride (PVC) pipe manufactured no more than six months prior to installation. Do not use damaged pipe.

3248.3 SAMPLING AND TESTING

Approved manufacturers of polyvinyl chloride (PVC) are listed on the Approved Products List.

Polyvinyl chloride (PVC) pipe manufacturing facilities are required to participate and be in compliance with AASHTO's National Transportation Product Evaluation Program (NTPEP) for producers of AASHTO M 304 PVC pipe. If a plant has a compliant NTPEP audit for AASHTO M 304 PVC pipe at the time the pipe is manufactured, then the plant has met requirements. Compliant plants are listed on the NTPEP website and can also be accessed through the Approved Products List.

Submit a manufacturer's Certificate of Compliance with each pipe shipment including date manufactured.

Metals and Metal Products

3301 REINFORCEMENT BARS

3301.1 SCOPE

Provide deformed and plain reinforcing steel for use as reinforcement in concrete construction.

3301.2 REQUIREMENTS

Provide reinforcement bars, other than wire, meeting the requirements of the following AASHTO specifications for the size, type and grade as shown on the plans or as required by the contract:

Table 3301-1
AASHTO Specifications Per Bar Type

Reinforcement Bars	AASHTO Specification Requirement
Billet steel bars	AASHTO M 31
Rail steel bars	AASHTO M 322 M/AASHTO M 322
Axle steel bars	AASHTO M 322 M/AASHTO M 322

If the plans or specifications do not specify the type or grade of reinforcement bars, provide Grade 60 [Grade 420] of any type except as modified by the following:

(1) Provide deformed billet steel reinforcement bars for use in a concrete bridges, including precast units, box culverts, and retaining walls.
(2) Provide deformed reinforcement bars of any type or grade for use in all other concrete structures, and
(3) If required or allowed by the contract, weld bars meeting the requirements of ASTM A 706 and having a yield point of at least 60,000 psi [414 MPa].

If required in the plans, provide epoxy coated reinforcement bars meeting the requirements of ASTM A775. Apply the coating in a fusion bonded epoxy coating plant certified by the CRSI.

Ensure the plant's quality control office maintains documentation required by CRSI certification, including test data and measurements taken at times and locations as directed by the Materials Engineer.

Fabricate, store, and place reinforcement in accordance 2472, "Metal Reinforcement."

3301.3 SAMPLING and TESTING

Sample and test reinforcement bars in accordance with the Schedule of Materials Control. If the Materials Engineer determines that the fusion bonded epoxy coating plant is not following approved coating procedures, correct the process and repair or replace the unacceptable material as directed by the Materials Engineer.

3302 DOWEL BARS

3302.1 SCOPE

Provide dowel bars for use in portland cement concrete pavements and other concrete applications as shown on the plans.

3302.2 REQUIREMENTS

A Epoxy Coated Steel Dowel Bars

Provide Grade 40 or Grade 60 steel dowel bars meeting the requirements of AASHTO M 31.

Epoxy coat the steel dowel bars in accordance with AASHTO M254 and as modified:
(1) Apply 7-13 mils epoxy coating thickness.
(2) Epoxy coat the ends of the dowel bars as required by the manufacturer. Apply epoxy coating in a fusion bonded epoxy coating plant certified by the CRSI or another organization approved by the Materials Engineer.

If cutting dowel bars to length by shearing, immediately repair all damaged coating and verify dowel bars have not exceeded the maximum deformation limits. Ensure that sheared dowel bars are not more than 0.04 in out of round, and that such damage does not extend more than 0.40 in from the end of the bar.

B Alternate Dowel Bars

Use alternate dowel bar materials as allowed or required by the contract.

3379 FENCE GATES

3379.1 SCOPE

Provide vehicular gates and pedestrian gates with pipe frames.

3379.2 REQUIREMENTS

A General

Use the same pipe, hardware, fittings, fence wire, and appurtenance materials to assemble all gates provided to the project.

B Materials

Use a frame made of galvanized steel pipe or aluminum alloy pipe.

B1 Galvanized Steel Pipe

Provide galvanized steel pipe meeting the requirements of ASTM A 53 for galvanized Standard Schedule 40 pipe with plain ends. Hydrostatic testing of the pipe is not required.

B2 Aluminum Alloy Pipe

Provide aluminum alloy pipe meeting the requirements of AASHTO M 181.

B3 Fittings and Hardware

As shown on the plans, use corner fittings, tops, stretcher bars, truss rods, and other required fittings, hardware, and appurtenances made of steel, malleable iron, wrought iron, or aluminum alloy. If using steel or iron, galvanize fittings or hardware in accordance with AASHTO M 181 after fabrication.

B4 Wire

Provide barbed wire, gate fabric for woven wire fence, and gate fabric for chain link fence as specified in 3376, "Fence Wire."

C Physical Properties

Use gate and members with physical properties as shown on the plans.

Use fittings, hardware, and other required appurtenances capable of being securely fastened and fitted to meet the requirements of the approved design.

Provide hinges and catch and locking devices meeting the requirements of an approved design.

3379.3 SAMPLING AND TESTING

Submit to the Engineer a manufacturer's Certificate of Compliance for each component in this section including Buy America compliance, if required.

Sample and test in accordance with the Schedule of Materials Control.

A Metal Pipe and Fittings.....3406

B Fence Wire and Fasteners 3376

3403 HOT-ROLLED STEEL FENCE POSTS

3403.1 SCOPE

Provide hot-rolled steel posts and angles for fencing.

3403.2 REQUIREMENTS

Provide hot-rolled steel line posts and angle section post assemblies for end, gate, corner, or intermediate brace assemblies meeting the requirements of ASTM A 702 and as shown on the plans.

3403.3 SAMPLING AND TESTING

Submit to the Engineer a manufacturer's Certificate of Compliance and a certified mill analysis showing the chemical composition of each delivered lot or heat of posts and compliance with Buy America, if required.

Sample and test in accordance with the Schedule of Materials Control. The Engineer may take samples for testing from any of the provided posts.

3406 STRUCTURAL METAL FENCE POSTS

3406.1 SCOPE

Provide tubular metal posts and rails, metal rolled-formed "C" posts, and fittings for fencing.

3406.2 REQUIREMENTS

A Materials

Provide posts and rails meeting the requirements of the plans and AASHTO M181, except as noted. Use Grade 1 round posts.

For Alternate Roll Formed posts, provide posts meeting the weight and property requirements of ASTM F1043 for Heavy Industrial Fence Framework Grade 50 with Type A coating.

Use line posts weighing 2.40 lb. per ft. nominal.

Use brace bars weighing 1.35 lb. per ft. nominal.

Apply coatings on posts, rails, and fittings after welding and fabrication. Provide tie wires, clips, and bands for fastening chain link fabric to posts, rails, and braces as specified in 3376, "Fence Wire." Use Type IV (PVC) posts, rails, and frames first coated with zinc and then coated with PVC Class B bonded to a thickness of at least 0.010 in.

B Dimensions

Provide posts, rails, and stretcher bars required by the contract meeting the requirements of AASHTO M181, except the Engineer will not accept posts greater than 1 in. shorter than the specified length.

3601 RIPRAP MATERIAL

3601.1 SCOPE

Provide stone and filter layer material for use in random or hand-placed riprap, gabion, and revet mattress construction.

3601.2 REQUIREMENTS

A Stones

A.1 Quality

Provide stone of the quality approved by the Department and meeting the following requirements:

(1) Each individual stone has at least one fractured face.
(2) Is free of soil or other debris before placement.
(3) Contains less than 10 percent of the following by weight:
  (3.1) Stones with defects that could cause rapid or excessive deterioration or degradation during service, such as cracks or seams;
  (3.2) Stones with a width or thickness less than 30 percent of the length.
(4) For carbonate quarry/bedrock material used in total or in part for riprap, the portion of the insoluble residue passing the #200 sieve is no greater than 10 percent.
(5) Use 100% virgin materials for riprap and granular filter

To determine suitable quality of stone, the Department may consider the results of laboratory tests, the performance of the stone under natural exposure conditions, the performance of the riprap from the same or similar geological formations or deposits, or other tests or criteria.

A.2 Type

A.2.a Random Riprap.....Table 3601-1

A.2.b Hand-Placed Riprap

Provide individual stones with a weight of at least 50 lb. The Department will not require a minimum weight for smaller stones required for filling in the narrow openings between individual stones (chinking).

A.2.c (Blank)

A.2.d Gabions and Revet Mattresses

Provide well graded stones for filling the baskets, ranging in size from 4 inches to 8 inches for gabions and 3 inches to 6 inches for revet mattresses.

Table 3601-1 Random Riprap Gradation Requirements						
		Approximate Percent of Total Weight Smaller than Given Weight				
		Class of Riprap				
Weight, *lb*	Size, *inch**	I	II	III	IV	V
2,000	30	—	—	—	—	100
1,000	24	—	—	—	100	—
650	21	—	—	—	—	75
400	18	—	—	100	—	—
250	15	—	—	—	75	50
120	12	—	100	75	50	—
50	9	—	75	50	—	—
15	6	100	50	—	—	10
5	4	—	—	—	10	—
2	3	50	—	10	—	—
—	2	—	10	—	—	—
—	1	10	—	—	—	—
* Weight to size conversion based on a specific gravity of 2.60 and a volume average between a sphere and cube						

B Filter Material

B.1 Granular Filter
Provide granular filter material in accordance with 3149, "Granular Material," and the following gradations:

B.1.a Under Class I Random Riprap 3149.2.G.1
Use Class 5 gradation requirements listed in Table 3138-3

B.1.b Under Other Riprap, Gabion, and Revet Mattress .....Table 3601-2

Table 3601-2 Granular Filter Material	
Sieve Size	Percent Passing by Weight
6 inch	100
3 inch	75 – 95
1 inch	35 – 75
No. 4	10 – 40
No. 10	5 – 25
No. 40	0 – 10
No. 200	0 – 5

B.2 Geotextile Filter.....3733

3601.3 SAMPLING AND TESTING
The Department will inspect the material for compliance to the requirements of this section. Obtain the Engineer's approval of the quality of the stone before delivering the stone to the project. The Engineer will inspect the stone for compliance to the gradation requirements after delivery of the stone to the project.

The Engineer will visually check riprap gradations. If the Contractor disagrees with the results of the Engineer's visual check, the Contractor will test the gradation based on weight, under supervision of the Engineer.

If the quantity of riprap for any class is greater than 40 yd^3, the Engineer may require construction of a control unit consisting of 4 yd^3 of riprap as a reference for size and quality compliance. Construct the control unit at the source or on the project. When the Engineer requires and approves a control unit for reference, maintain the control unit during riprap construction and incorporate the stones from the control unit as the last stones placed in the riprap construction. Use production stone equivalent to the stone placed in the approved control unit.

If using carbonate quarry/bedrock materials in total or in part for riprap materials, sample and test at the rates specified in the Schedule of Materials Control for the following test(s):

Insoluble Residue Laboratory Manual Method 1221

3876 SEED

3876.1 SCOPE

Provide seed for planting to establish temporary and permanent vegetative cover.

3876.2 REQUIREMENTS

Provide seed meeting the following requirements and characteristics:

(1) From a vendor listed on the Approved/Qualified Product List and approved to blend or sell the type of mix used;
(2) Meeting the requirements of Minnesota Statutes 21.80-21.91 and any applicable federal regulations, including those governing labeling and weed seed tolerances;
(3) Conditioned to remove all pieces of stem, straw, or other chaff longer than 1½ in. so that it can pass through a drill seeder without plugging;
(4) Supplied on a pure live seed (PLS) basis; and
(5) Meeting the tolerance requirements for germination and purity factors of the following Minnesota Seed Law Rules applied to seed lots sampled and tested by the following Association of Official Seed Analysts (AOSA) methods:
    (5.1) 1510.0050,
    (5.2) 1510.0060,
    (5.3) 1510.0070,
    (5.4) 1510.0080,
    (5.5) 1510.0090, and
    (5.6) 1510.0100.

Apply Rhizobial inoculants to legume seed with the rhizobial culture appropriate for the species being inoculated as directed by the manufacturer or as shown on the special provisions.

Apply Mycorrhizal inoculants for native warm season grasses as shown on the plans.

Apply Azospirillum innoculants to grass seed as shown on the plans.

Use inoculants before the expiration date. Provide a label showing the expiration date of the innoculant.

Store seed and innoculant in accordance with 1606, "Storage of Materials," and under controlled conditions. Before planting, maintain seed at or below 70 °F and at or below 10 percent moisture content, and protect seed from rain, direct sunlight, rodents, and insects.

The Department defines PLS as the product of the percent of viable seed ("total germination and hard seed or dormant seed when applicable") multiplied by the percent of pure seed divided by 100 percent.

A (Blank)

B (Blank)

C (Blank)

C.1 (Blank)

C.2 (Blank)

C.3 (Blank)

D Seed Mix Designations

D.1 Standard Seed Mixes

Use seed of the species and germplasm meeting the requirements of the Seeding Manual and the Seed Mixture Components Requirements Table, or as specified in the special provisions.

Table 3876-1
State Seed Mixes*†

Category & Mix No.	PLS Rate, *lb/acre*	Name
21-111	100	Oats Cover Crop
21-112	100	Winter Wheat Cover Crop
21-113	110	Soil Building Cover Crop
22-111	30	Two-year Stabilization
22-112	40	Five-year Stabilization
25-121	61	Sandy General Roadside
25-131	220	Low Maintenance Turf
25-141	59	Mesic General Roadside
25-142	45	Agricultural Roadside
25-151	200	High Maintenance Turf
32-241	38	Native Construction
33-261	35	Stormwater South and West
33-262	44	Dry Swale / Pond
33-361	35	Stormwater Northeast
34-171	5.3	Wetland Rehabilitation
34-181	5	Emergent Wetland
34-261	31.5	Riparian South & West
34-262	14.5	Wet Prairie
34-271	12	Wet Meadow South & West
34-361	31.5	Riparian Northeast
34-371	12.5	Wet Meadow Northeast
35-221	36.5	Dry Prairie General
35-241	36.5	Mesic Prairie General
35-421	11	Dry Prairie Northwest
35-441	11	Mesic Prairie Northwest
35-521	12.5	Dry Prairie Southwest
35-541	12	Mesic Prairie Southwest
35-621	11	Dry Prairie Southeast
35-641	12	Mesic Prairie Southeast
36-211	34.5	Woodland Edge South & West
36-311	33.5	Woodland Edge Northeast
36-411	35.5	Woodland Edge Northwest
36-711	35.5	Woodland Edge Central

D.2 Site Specific Seed Mixes

Provide seed mixes in accordance with *Native Seed Mix Design for Roadsides* if shown on the plans.

E Blending

Provide uniformly blended seed mixes as required by the contract and meeting the requirements of the Seeding Manual. Blend mixes meeting the requirements of the Department's Approved Seed Vendor Agreement.

E.1 Non-native mixes and cover crop mixes

Combine all components of non-native mixes and cover crop mixes

E.2 Native seed mixes

Blend and package components of native seed mixes according to size to allow installation from the appropriate seed box of native seeding equipment and in accordance with the following:

(1) Combine the seeds of sedges and rushes for installation by hand or with the small seed box,
(2) Combine the seeds of small and medium seeded forbs for installation with the small seed box,
(3) Combine the seeds of most grasses and large-seeded forbs for installation with the fluffy seed box, and
(4) Combine large seeds of cover crop species such as oats and winter wheat for installation with the grain box.

F Minimum PLS

Provide seed meeting the minimum purity and germination requirements for certification in accordance with the seed certification standard on file with the appropriate seed certifying agency. If using non-certified seed approved as substitutions, provide seed meeting the minimum PLS requirement listed on the Seed Mixture Component Requirements Table.

G Acceptable Varieties and Origin

Use seed of introduced species that has been certified by the Minnesota Crop Improvement Association (MCIA) or the appropriate seed certifying agency in the seed's state of origin. Use seed of varieties listed in the document "Seed Mixture Component Requirements" which includes approved substitutions and is available on the MnDOT website.

Where native species occur in predominately non-native mixes, use seed varieties as listed in the Seed Mixture Component Requirements Table or seed certified as Source Identified by the MCIA.

In native seed mixtures, use seed of native species certified in the Source Identified class by the MCIA.

In native seed mixtures, use seed of native species with a genetic origin from Minnesota or the following regions of adjacent states:

Table 3876-2
Native Species from Adjacent States

State	Counties
North Dakota	Barnes, Benson, Cass, Cavalier, Dickey, Eddy, Foster, Grand Forks, Griggs, Lamoure, Nelson, Pembina, Ramsey, Ransom, Richland, Sargent, Steele, Stutsman, Towner, Traill, Walsh
South Dakota	Aurora, Beadle, Bon Homme, Brookings, Brown, Clark, Clay, Codington, Davison, Day, Deuel, Douglas, Grant, Hamlin, Hanson, Hutchinson, Jerauld, Kingsbury, Lake, Lincoln, Marshall, McCook, Miner, Minnehaha, Moody, Roberts, Sanborn, Spink, Turner, Union, Yankton
Iowa	Allamakee, Bremer, Buena Vista, Butler, Cerro Gordo, Cherokee, Chickasaw, Clay, Clayton, Dickinson, Emmet, Fayette, Floyd, Franklin, Hancock, Howard, Humboldt, Kossuth, Lyon, Mitchel, O'Brien, Osceola, Palo Alto, Plymouth, Pocahontas, Sioux, Winnebago, Winneshiek, Worth, Wright
Wisconsin	Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Crawford, Douglas, Dunn, Eau Claire, Grant, Iowa, Iron, Jackson, La Crosse, Lafayette, Monroe, Pepin, Pierce, Polk, Price, Richland, Rusk, Saint Croix, Sawyer, Taylor, Trempealeau, Vernon, Washburn

G.1 Range-Limited seed mixes

If a seed mix is identified on the plans as Range-Limited, supply seed in accordance with the following requirements as specified on the plans:

(1) Range-Limited 150: At least 85 percent of native components have a genetic origin from within 150 miles of the project,
(2) Range-Limited 75: At least 85 percent of native components have a genetic origin from within 75 miles of the project,
(3) Range-Limited 25: At least 85 percent of native components have a genetic origin from within 25 miles of the project.

H Substitutions

The Contractor may substitute species or germplasm listed in the Seeding Manual with corresponding species or germplasm listed in the Seed Mixture Component Requirements Table.

3876.3 SAMPLING AND TESTING

A Testing and Viability

Provide seed tested in accordance with the official rules for testing on file with the AOSA and meeting the minimum germination requirements of 3876.2.F, "Minimum PLS," during installation. Plant seed within 12 months of viability testing exclusive of the month the test was completed.

Upon request by the Engineer, provide seed test reports from a registered seed technologist for each lot of seed being used. Take samples of seed lots delivered to the project in accordance with the Schedule for Materials Control for testing and inspection, or more often as requested by the Engineer. The Department will use a tetrazolium test in lieu of a standard germination test for quality control. If the Department's inspection and testing results disagree with those obtained at the origin, the Department's findings will be conclusive and binding. The Contractor may challenge the Department's seed test results and may request re-testing at no additional cost to the Department.

B Blank

C Labeling

Label each container of seed with the following information (in addition to information required by the Minnesota Seed Law, Section 21.82):

(1) Total PLS weight for the container,
(2) Net weight for the container,
(3) Area covered by the amount of seed in the bag when applied at the rate specified for that mix in Seeding Manual or special provision,
(4) When listing origin of mix components, list county of genetic origin for native species, and
(5) PLS percent for each component
(6) Variety of each component for which a variety is required according to the Seed Mixture Component Requirements Table

List the following information for each mix component that is 5 percent or less of the seed mix (include on the label for each container or supply as a separate sheet for each seed mix lot):

(1) Species,
(2) Variety,
(3) Origin (production area for introduced species; county of genetic origin for native species),
(4) Pure seed (percent),
(5) Germination (percent),
(6) Hard (dormant) seed (percent), and
(7) PLS (percent) for each component.

When bags of small seeded species are placed inside larger bags of large-seeded species of the same mix, mark smaller bags to clearly identify the components contained in the bag and what mix they belong to. Attach the MnDOT Approved Seed Vendor tag and the seed label to the outer bag.

Attach applicable certification tags from appropriate seed certifying agencies to each bag containing certified seed or provide a certification certificate with the certified seed.

Attach a MnDOT Approved Seed Vendor tag to each bag of seed. Ensure that the tag matches the type of mix labeled.

The Department considers the labeling and tags required in this section and by state and federal law as the certificate of compliance for the provided seed.

3877 TOPSOIL MATERIAL

3877.1 SCOPE

Provide topsoil material for use as a medium to establish plant growth for water quality and permanent erosion protection. Provide manufactured soils for use as a medium for treating and filtering stormwater in rain gardens, horizontal filter berms, dikes, bioswales, and bioslopes.

3877.2 REQUIREMENTS

Provide loam to sandy loam topsoil from Type A and/or Type B horizon soils defined in the soil profile section of the Grading and Base Manual, from alluvial deposits, or blended from defined sand, compost, and loam to sandy loam topsoil sources. Manufactured topsoil's in section E, F, G, and H are blended on a volume basis of materials. When the individual components have been verified to meet the appropriate specification, the blended material in the ratio indicated shall meet this specification. In addition to the requirements, any of the topsoil types may require soil conditioners, plant hormones, or root stimulators in accordance with 3896, "Soil and Root Additives."

Aggregate material from sources other than gravel pits and quarries must also meet the minimum contaminants requirements in US EPA 503 or Minnesota Rule 7035.2846 Subp. 6, Sec. A.

A Common Topsoil Borrow

Provide Common topsoil borrow ranging from a silt loam, loam, clay loam, sandy clay loam, or sandy loam soils for general use as a turf growing medium and in accordance with Table 3877-1. Common topsoil borrow material is a blend of Type A and/or Type B horizon soils defined in the soil profile section of the Grading and Base Manual, and is similar to topsoil found adjacent to the project.

Table 3877-1
Common Topsoil Borrow Requirements

Requirement	Range	Test Method
Material passing No4 in	≥ 85%	—
Clay	5% – 35%	ASTM D 422
Silt	5% - 70%	ASTM D 422
Sand	10% - 75%	ASTM D 422
Organic matter	3% – 15%	ASTM D 2974
pH	6.1 – 7.8	ASTM G 51

Largest materials size dimension not to exceed 2.5 inches

B Loam Topsoil Borrow

Provide topsoil borrow consisting mostly of loam ranging into sandy clay loam, sandy loam, silt loam, and clay loam soils as a plant growing medium for landscape and planting beds and in accordance with Table 3877-2:

Table 3877-2
Loam Topsoil Borrow Requirements

Requirement	Range	Test Method
Material Passing the ¾ in	100%	ASTM D 422
Material passing No. 4	≥ 90%	-
Clay	5% – 35%	ASTM D 422
Silt	10% – 60%	ASTM D 422
Sand	15% – 60%	ASTM D 422
Organic matter	3% – 15%	ASTM D 2974
pH	6.1 – 7.5	ASTM G 51
Soluble salts	≤ 0.15 siemens/m	—

C Sandy Clay Loam Topsoil Borrow

Provide topsoil borrow mostly consisting of a sandy clay loam and ranging into clay loam, sandy loam, and loam soils for use as a plant growing medium in critical areas, such as steep slopes and as a top dressing for Turf Reinforcement Mats, and in accordance with Table 3877-3:

Table 3877-3 Sandy Clay Loam Topsoil Borrow Requirements		
Requirement	**Range**	**Test Method**
Screened	—	—
Material passing the ¾ in	100%	ASTM D 422
Material passing No.4	≥ 95%	ASTM D 422
Clay	10% – 35%	ASTM D 422
Silt	0% – 40%	ASTM D 422
Sand	30% – 75%	ASTM D 422
Organic matter	3% – 15%	ASTM D 2974
pH	6.0 – 7.5	ASTM G 51
Soluble salts	≤ 0.15 siemens/m	—

D Blank

E Rooting Topsoil Borrow

Provide topsoil borrow consisting of three blended components of loam topsoil, sand, and compost for use as a well-drained course sand medium for vegetative plant restoration, plant preservation, or as a plant growing medium for rooting, water quality, and infiltration. The components consist of the following by volume.

(1) Sixty percent sand in accordance with 3149.2.J, "Fine Filter Aggregate;" or 3149.2K, "sand cover"

(2) Twenty percent Grade 2 compost in accordance with 3890, "Compost;" and

(3) Twenty percent topsoil meeting the requirements of Loam Topsoil Borrow.

Supplement with root additives to stimulate root establishment in water quality treatment facility.

F Boulevard Topsoil Borrow

Provide topsoil borrow containing three blended components consisting of loam topsoil, sand, and compost for use as structural soil for plant establishment in streetscape boulevards. The components consist of the following by volume:

(1) One-third topsoil meeting the requirements of Loam Topsoil Borrow;
(2) One-third sand accordance with 3149.2J, "Fine Filter Aggregate;" or 3149.2K, "sand cover" and
(3) One-third compost in accordance with 3890, "Grade 2 Compost."

G Filter Topsoil Borrow

Provide topsoil borrow containing two blended components of sand and compost for water quality, plant growing medium, and filtration medium with a filtration rate of at least 4 in/h. The components consist of the following by volume:

(1) 60%-80% sand meeting the gradation requirements of 3126, "Fine Aggregate for Portland Cement Concrete," and
(2) 20%-40% Grade 2 compost per 3890, "Compost."

H Organic Topsoil Borrow

Provide topsoil borrow containing two blended components of topsoil, and compost for a plant growing medium to enhance existing soils. The components by volume consist of:

(1) 50% existing salvaged topsoil, and
(2) 50% compost meeting requirement of 3890 "Grade 2 Compost."

Provide Type 4 fertilizer in accordance with 3881, plant hormones in accordance with 3896.

3877.3 SAMPLING AND ACCEPTANCE

Provide material from vendors that have been approved by Mn/DOT's Erosion and Storm water Management Unit or submit a list of prospective sources for topsoil material to the Engineer at the preconstruction meeting to allow for inspecting, testing, and approving the sources. Submit preapproval test results to the Office of Environmental Stewardship, Erosion & Stormwater Management Unit. If federal or state chemical or biological requirements conflict, provide material meeting the most stringent requirement.

Test blended topsoil for each individual component before blending.

The contractor shall conduct fertility testing in accordance with the standard testing procedures of the University of Minnesota Soils Testing Laboratory, Soil Science Department.

3885 ROLLED EROSION CONTROL PRODUCTS

3885.1 SCOPE

Provide temporary rolled out products to control erosion, aid the establishment of vegetation, and reinforce vegetation, and temporary reinforce slopes, ditch bottoms, and shorelines. Provide netting opening dimensions large enough to germinate plants, reduce animal entanglement, and keep fill material intact.

3885.2 REQUIREMENTS

A Erosion Control Blanket Requirements

Provide blankets that conform to the general requirements listed in Table 3885-1, Table 3885-2, and Table 3885-3

Table 3885-1
Erosion Control Blanket Criteria

Criteria		Category 0	
		Wood Cellulose Fiber 1S, NT	**Wood Fiber 0S**
mass per yd^2 (min) ASTM D 6475		6.0 oz	8.0 oz
Permissible Shear stress, Minimum (non-vegetated) ASTM D 6460		0.5 lb/Sq. ft.	0.5 lb/sq. ft.
Target Service Life		3 months	3 months
Fill	Fiber length, 80% greater than	0.5 in	6 in
	Material	100% Wood Cellulose	100% Excelsior
Netting	Material	Degradable	-
	Degradation ASTM D4329, Cycle A	≤3 months	-
Stitching	Material	-	Degradable
	Degradation ASTM D4329, Cycle A	-	<3 months
	Max spacing		4 in

0S – No netting, stitching only
1S – Netting on one side
NT – No thread/stitching

Table 3885-2
Erosion Control Blanket Criteria

Criteria			*Category 3P, Category 3N		*Category 4P, Category 4N	
			Straw 2S	**Wood Fiber 2S**	**Straw-Coconut 2S**	**Wood Fiber 2S**
mass per yd^2 (min) ASTM D 6475			6.0 oz	6.0 oz	6.0 oz	8.0 oz
Permissible Shear stress, (min) (non-vegetated) ASTM D6460			1.75 lb/sq. ft	1.75 lb/sq. ft	2.00 lb/sq. ft	2.00lb/sq. ft
Tensile Strength ASTM D6818		MD	≥75 lbs/ft		≥100 lbs/ft	
		TD	≥40 lbs/ft		≥40 lbs/ft	
Fill	Fiber length, 80% greater than		3 in	6 in	3 in	6 in
	Material		100% Straw	100% Excelsior	70% Straw, 30% Coconut	100% Excelsior
	Target Service Life		12 months	12 months	24 months	24 months
Netting	Material		**Degradable Synthetic or Natural	**Degradable Synthetic or Natural	**Degradable Synthetic or Natural	**Degradable Synthetic or Natural
	Netting Degradation ASTM D4329 Cycle A		6 months	6 months	9 months	9 months
Stitching	Material		**Degradable Synthetic or Natural	**Degradable Synthetic or Natural	**Degradable Synthetic or Natural	**Degradable Synthetic or Natural
	Stitching Degradation ASTM D4329, Cycle A		3 months	3 months	3 months	3 months

2S – Netting on two sides
* 3P &4P = Synthetic netting, 3N & 4N = Natural netting and natural stitching
** combination of photo, heat, and moisture degradation

Criteria	Table 3885-3 Erosion Control Blanket Criteria	
	Category 6	
	Straw-Coconut 3S	Wood Fiber 3S
Min mass per yd^2 ASTM D 6475	10.2 oz	10.2 oz
Fiber Length, 80% greater than	3 in	6 in
Material	70% Straw and 30% Coconut Fibers	100% Excelsior Fibers
Netting and Stitching Target Service Life	36 months	36 months
Netting and Stitching Material	Black UV Stabilized Polypropylene	Black UV Stabilized Polypropylene

A.1 Material Fiber

Provide fill material with a uniform web of interlocking fibers, with uniform thickness, and with the material fibers evenly distributed over the entire area of the blanket.

A.2 Anchors

Provide anchors for each category of blanket meeting the requirements in Table 3885-4.

Table 3885-4 Anchor Specification			
Blanket Category	Material	Type	Minimum Length, *in*
0	Biodegradable	Stake	5
3 and 4*	Steel Wire	11 Gauge	6
6	Steel Wire	11 Gauge	8
* For frozen ground use 60D (6 in.) common nail with washer			

B Turf Reinforcement Mat Requirements

Provide Turf Reinforcement Mats (TRM) made of a three-dimensional matrix of synthetic material, continuously bonded at filament intersections meeting the requirements of Table 3885-5.

Table 3885-5 Turf Reinforcement Mat Criteria			
TRM Category	**Minimum Permissible Shear Stress ‖, *lb/sq ft***	**Minimum Tensile Strength †, *lb/ft* ASTM-D 6818**	**Matrix Composition ‡**
1	2.1	125	Nylon, Polypropylene, Polyolefin, or Polyester
*2	6	150	Nylon, Polypropylene, Polyolefin, or Polyester
*3	8	175	Nylon, Polypropylene, Polyolefin, or Polyester
*4	10	1370	Nylon Polypropylene, Polyolefin, or Polyester

* Provide mats with cells at least ⅜ - ¾ in in depth to allow soil filling and retention.
‖ ASTM D 6460-07 vegetated.
† Minimum Average Roll Value of either direction.
‡ , UV stability ASTM D4355 at 500 hours of 80 percent.

B.1 Fill Material

Fill category 2, 3, and 4 Turf Reinforcement Mats (TRM) with 1/2 in soil meeting table 3877-3, "sandy clay loam topsoil borrow".

B.2 Anchors

Provide anchors for Turf reinforcement Mat meeting the requirements in Table 3885-6.

Table 3885-6
Anchor Specification

Blanket Category	Material	Type	Minimum Length, *in*
TRM *	Steel Wire	11 Gauge	10
* Adjust anchor selection to assure RECP is held in place securely.			

C Flexible Concrete Geogrid Mat

Provide a flexible concrete mat consisting of concrete blocks meeting requirements of ASTM D6684 and connected together by an interlocking geogrid. Place the mats side by side and anchor to provide one homogeneous erosion protection system.

C.1 Physical Requirements

Provide a minimum open area of 10% that allows topsoil infilling, if specified.
Minimum permissible Shear stress as per ASTM 6460 (vegetated) 20 lbs. per sq. ft.

C.2 Interlocking Geogrid

Interlocking geogrid shall have the following physical characteristics of Table 3885-7.

Table 3885-7 Interlocking Geogrid Characteristics

Mass/Unit Area (min)	ASTM D-5261	7.0 oz/yd2
Aperture Size (min)	Measured	1.6 x 1.6 inch
Wide Width Tensile Strength		
Machine Direction (MD) (Min)	ASTM D-6637	2,055 lb/ft
Transverse Direction (TD) (min)	ASTM D-6637	2,055 lb/ft
Elongation at Break (Max)	ASTM D-6637	6 %
Tensile Strength @ 2%		
Machine Direction (MD) (min)	ASTM D-6637	822 lb/ft

C.3 Anchoring System

Provide Number 4 J hooked rebar, minimum 2 foot length for pneumatic driven installation depth, flush to Flexible Concrete Geogrid Mat surface.

C.4 Concrete

Provide wet cast blocks meeting Specification 2461 "Structural Concrete" and the following:

(6) Manufactured in a plant with a Department approved quality control plan,
(7) Design air content of 6.5 percent,
(8) Absorption no greater than 7.0 percent when tested in accordance with ASTM C 140, and
(9) Minimum Design Strength of 4000 psi at 28 days when tested in accordance with ASTM C 140:

D Concrete Fabric Mat

Provide Concrete Fabric Mat (CFM) that is a cement impregnated fabric that hardens when hydrated to form a water resistant mat. It can be installed underwater and has a working time of several hours after hydration.
It shall meet the following requirements of Table 3885-8

Table 3885-8 Physical Characteristics

Type	Thickness (in)	Dry Weight (sq ft)	Hydration Min. Water volume (gal/ft2)	Compressive strength ASTM C473-07 (10 day, psi)
A	0.20	1.43	0.2	5800
B	0.31	2.46	0.3	5800
C	0.51	3.89	0.5	5800

Provide rolls capable of handling from spreader beams or bars. Provide proper storage and handling methods capable of dry storage until placement. Provide means capable of cutting into structure configurations and openings prior to hydration and again after placement as necessary for proper fit and transport of flowing water.

D.2 Anchor Pins

Provide 3 foot long, formed crozier or U-shaped, sharpened #3 rebar pins or other manufactured recommendation anchoring systems.

D.3 Overlap and Lap-Joint Bonding Agents

Provide appropriate sealant capable of bonding to both the PVC backing and fiber surface of the Concrete Fabric Mat. The sealant must work in both wet and dry conditions prior to hydration and remain functional during hydration.

D.4 Hydration Water

Provide water to the Concrete Fabric capable of surface saturation when no longer applying water for 2 minutes. Provide sufficient water 1 hour later on fabrics thicker than 0.5 inches, ditch grades greater than 2 percent, slopes greater than 3:1, and temperatures greater than 80 degrees Fahrenheit to complete the hydration process.

3885.3 SAMPLING AND TESTING

Approved products for this specification are on file on the MnDOT web page in the Materials Engineering Section.

The Contractor shall inspect the flexible concrete mats upon delivery. Flexible concrete Mats missing more than 4 concrete blocks per 80 square feet section shall be rejected.

3887 FLOTATION SILT CURTAIN

3887.1 SCOPE

Provide flotation silt curtain to contain suspended sediment and floating debris in open water.

3887.2 REQUIREMENTS

Provide floatation silt curtains meeting the following requirements and characteristics:

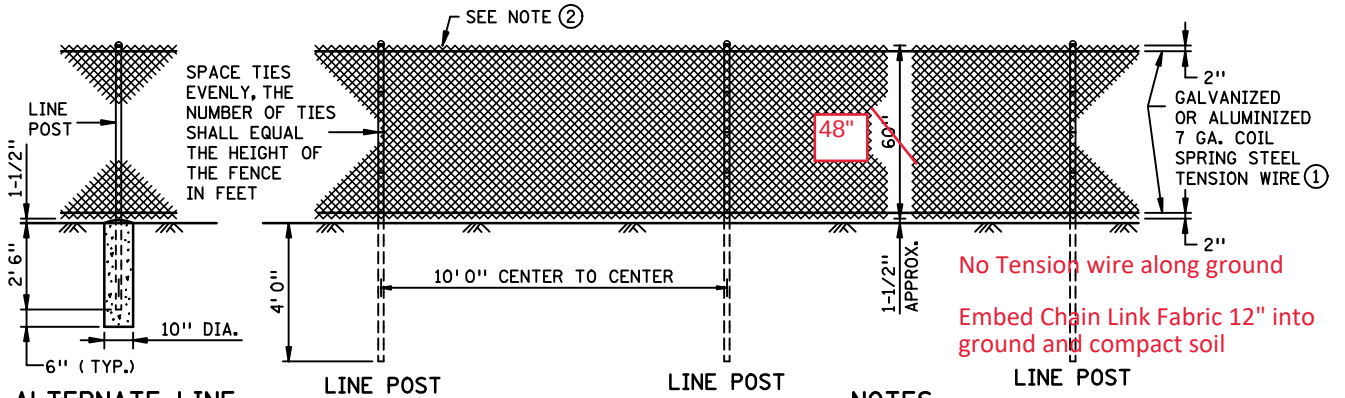
(1) Made of fabric fastened to a flotation carrier,
(2) Weighted along the bottom edge,
(3) Depth as shown on the plans and referring to the dimension of the curtain fabric extending below the flotation portion of the curtain, and
Table 3887-1, "Flotation Silt Curtain Requirements."

Table 3887-1
Flotation Silt Curtain Requirements

Characteristic	Type	
	Light Duty	**Heavy Duty**
Curtain fabric material type	Impermeable, vinyl-nylon laminate	Impermeable, vinyl-coated nylon
Weight *oz per sq. yd [kg per sq. m]*	18 [0.6]	0.22 [0.75]
Grab tensile strength, *lb [kN]**	300 [1.3]	500 [2.2]
Depth of curtain**	2 ft – 10 ft [0.6 m - 3 m]	2 ft – 10 ft [0.6 m - 3 m]
Flotation, *in [mm]*	6 [150] diameter marine quality expanded polystyrene	8 [200] diameter marine quality expanded polystyrene
Net buoyancy, *lb per ft [N per m]*	13 [200]	20 [300]
Top load carrying components	Fabric only	Fabric plus $^{5}/_{16}$ in [8 mm] galvanized steel cable at least 9,800 lb [40 kN] break strength
Ballast	≥0.7 lb per ft [1.0 kg per m] enclosed ¼ in [6 mm] galvanized chain	≥1.1 lb per ft [1.6 kg per m] enclosed $^{5}/_{16}$ in [8 mm] galvanized chain
Connection between sections	Laced grommets	Aluminum collar reinforced quick disconnects

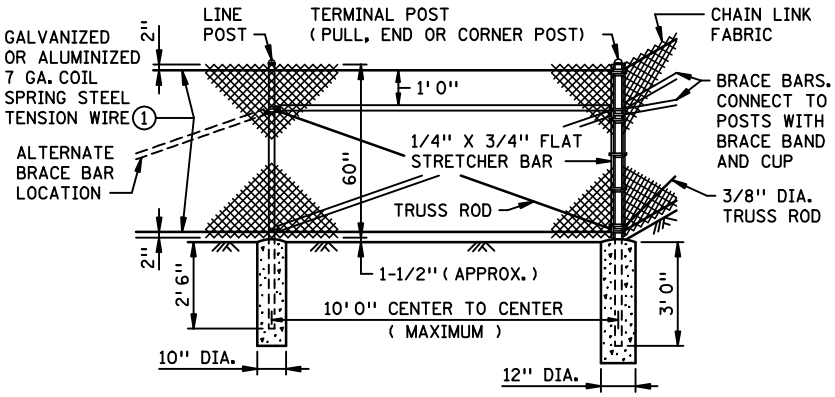
* Minimum average roll value meeting the requirements of ASTM D 4632
** As required by the contract.

Remove the curtain upon completion of work. Do not allow re-suspension of sediment or loss of trash and oil into the water during the curtain removal.



ALTERNATE LINE POST ANCHORAGE

LINE SECTION



PULL, END OR CORNER POST & ADJACENT LINE POST

NOTES:

TERMINAL POSTS SHALL BE:
END, CORNER OR PULL POSTS, 8'-0" LONG NPS (NOMINAL PIPE SIZE) 2" NOMINAL (NOM.) INSIDE DIAMETER (I.D.) AASHTO M181, 3.65 LBS./FT. OR ASTM F1043 ROLL FORMED, (3-1/2" X 3-1/2") 5.10 LBS./FT.

LINE POSTS SHALL BE: 7' 6" (CONCRETE BASE ONLY) OR 9'-0" LONG NPS 1-1/2" NOM. I.D. AASHTO M181, 2.72 LBS./FT. OR ASTM F1043 ROLL FORMED (1-5/8" X 1-7/8") 2.40 LBS./FT. MIN.

BRACE BARS SHALL BE: NPS 1-1/4" NOM. I.D. AASHTO M181, 2.27 LBS./FT. OR ASTM F1043 ROLL FORMED (1-1/4" X 1-5/8") 1.35 LBS./FT.

PULL POST SPACING NOT TO EXCEED 500 FT.

CHAIN LINK FABRIC SHALL BE:
9 GA., 2 IN. MESH WITH KNUCKLED SELVAGE TOP AND BOTTOM, AND CONFORM TO THE REQUIREMENTS OF AASHTO M181 TYPE II OR IV. DESIGN 60-9322 SHALL BE FURNISHED IN TYPE II (ALUMINUM COATED STEEL). DESIGN 60V-9322 SHALL BE TYPE IV (VINYL COATED FABRIC).

WIRE TIES MAY BE 9 GA. GALVANIZED OR ALUMINIZED STEEL OR 0.179 IN. MIN. ALUMINUM ALLOY CONFORMING TO ASTM B211, ALLOY 1100-H18. USE 12 GA. GALVANIZED STEEL OR 9 GAGE ALUMINUM ALLOY 1350-H19 HOG RINGS FOR TENSION WIRE TIES.

WHERE THE FENCE MUST CROSS SMALL BODIES OF WATER, SUCH AS PONDS THAT FREEZE DURING THE WINTER, USE 11 GA. GALVANIZED OR ALUMINIZED STEEL OR 0.149 IN. ALUMINUM TIES. PROVIDE ONLY 2 TIES BETWEEN LINE POSTS.

WHEN THE DRIVEN LINE POST ANCHORAGE IS USED, THE REQUIREMENTS FOR THE ALTERNATE CONCRETE ANCHORAGE IS WAIVED.

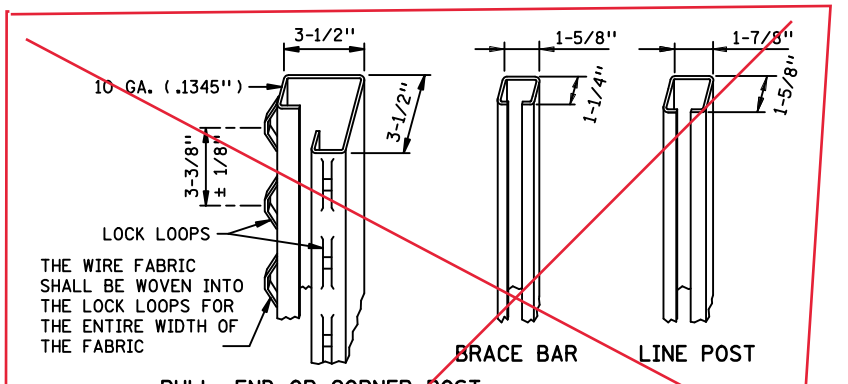
A CONCRETE ANCHORAGE SHALL BE USED FOR ALL TERMINAL POSTS AND FOR FIRST LINE POST(S) ADJACENT TO THE TERMINAL POSTS.

THE TOP OF THE CONCRETE ANCHORAGE SHALL BE CROWNED 1 IN. ABOVE THE NATURAL GROUND.

① A BOTTOM TENSION WIRE IS REQUIRED ONLY WHEN THE FENCE IS 10 FT. OR LESS FROM THE EDGE OF A ROADWAY SHOULDER.

② FENCES WITH A TENSION WIRE SHALL HAVE EITHER: AN ASTM F552 LINE POST CAP (LOOP TYPE), WITH THE TENSION WIRE PASSING THROUGH THE POST CAP WHEN USING ROUND POSTS; OR USE METHOD SHOWN IN "ALTERNATE ROLL FORMED END OR CORNER POST" DETAIL, IF USING ALTERNATE POSTS. A HOG RING SHALL ATTACH THE TENSION WIRE TO THE FABRIC AND SHALL BE LOCATED NO MORE THAN 6 IN. ON EACH SIDE OF A POST. ADDITIONAL HOG RINGS SHALL BE SPACED A MAXIMUM 18 IN. APART.

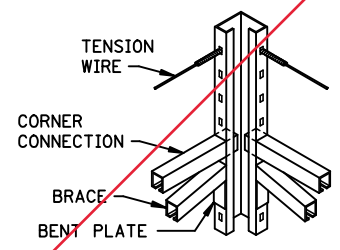
SEE SHEET 2 OF 2 FOR GATE DETAILS.



PULL, END OR CORNER POST

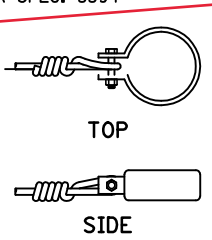
ALTERNATE ROLL FORMED DETAILS

GALVANIZE PER SPEC. 3394



ALTERNATE ROLL FORMED END OR CORNER POST

TOP & BRACE RAIL CORNER CONNECTION



TYPICAL WIRE END CLAMP

DESIGNATION:
FENCE FABRIC HEIGHT-9322: EXAMPLE: DESIGN 60-9322

APPROVED OCTOBER 21, 2008

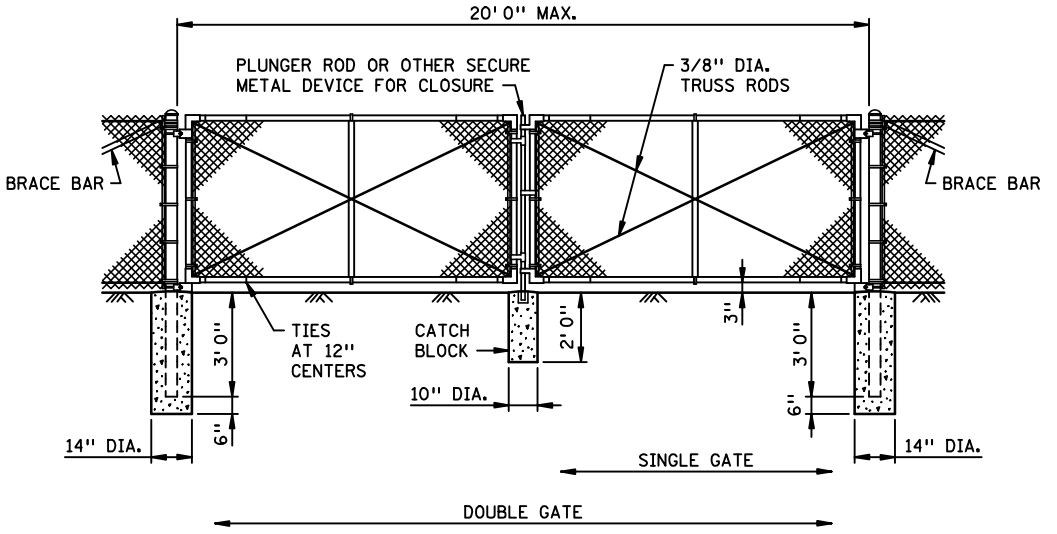
STATE DESIGN ENGINEER

DEPARTMENT OF TRANSPORTATION

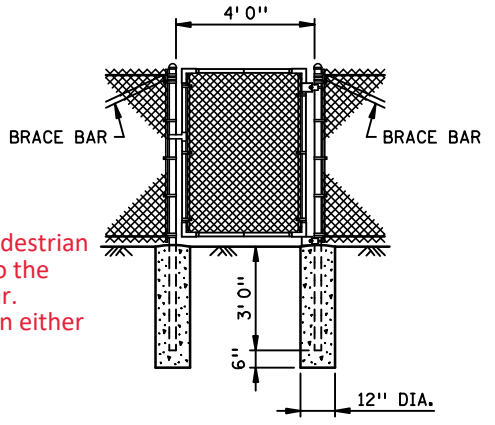
CHAIN LINK FENCE

STEEL POSTS - LINE POSTS

SPECIFICATION REFERENCE	STANDARD PLATE NO.
2557	9322K
REVISED 12-10-2008 M.J.E.	1 OF 2



VEHICULAR GATE



PEDESTRIAN GATE

Modify Pedestrian gate height.
Furnish and install cross bar below pedestrian gate. Embed Chain link fabric 12" into the ground and connect fabric to cross bar.
Furnish and install electrical ground on either side of gate opening.

NOTES:

POSTS FOR PEDESTRIAN GATES SHALL BE:
NPS 2" NOM. I.D. AASHTO M181, 3.65 LBS./FT., 8'-0" LENGTH.

POSTS FOR VEHICULAR GATES SHALL BE:
NPS 3-1/2" NOM. I.D. AASHTO M181, 9.12 LBS./FT., 8'-0" LENGTH.

FRAMES FOR PEDESTRIAN GATES SHALL BE:
NPS 1" NOM. I.D. AASHTO M181, 1.68 LBS./FT.

FRAMES FOR VEHICULAR GATES SHALL BE:
NPS 1-1/2" NOM. I.D. AASHTO M181, 2.72 LBS./FT.

SEE SHEET 1 FOR POST, FABRIC AND BRACE BAR REQUIREMENTS.

APPROVED OCTOBER 21, 2008 STATE DESIGN ENGINEER	STATE OF MINNESOTA DEPARTMENT OF TRANSPORTATION CHAIN LINK FENCE GATES	SPECIFICATION REFERENCE 2557	STANDARD PLATE NO. 9322K 2 OF 2

Material Specification 584—Structural Timber and Lumber

1. Scope
The specification covers the quality of structural timber, lumber, and plywood.

2. Grading
Structural timber and lumber shall be graded in accordance with the grading rules and standards, applicable to the specified species adopted by a lumber grading or inspection bureau or agency recognized as being competent and that conform to the basic principles of ASTM Standard D 245. The material supplied according to the commercial grading rules shall be of equal or greater stress value than the specified stress-grade.

3. Quality of material
All material shall be sound wood free from decay and disease damage. Boxed heart pieces of Douglas fir or redwood shall not be used in stringers, floor beams, caps, posts, sills, or other principal structural members. Boxed heart pieces are defined as timber so sawed that at any section in the length of a sawed piece the pith lies entirely inside the four faces.

4. Heartwood requirements
All timber and lumber specified for use without preservative treatment shall contain a minimum of 75 percent heartwood on any diameter or on any side or edge, measured at the point where the greatest amount of sapwood occurs. This requirement shall not apply to timber and lumber for which pressure treatment with wood preservative is specified.

5. Sizes
The sizes specified are nominal sizes. Unless otherwise specified, the material shall be furnished in American Standard dressed sizes.

6. Marking
Each piece of timber and lumber shall be legibly stamped or branded with an official grade identification. Plywood shall be legibly stamped with an official mark designating the grade, type, and surface finish as described in the cited Product Standard.

Material Specification 585—Wood Preservatives and Treatment

1. Scope

This specification covers the quality of wood preservatives, treatment processes, quality of treated material, and marking related to preservative treatment. Included are requirements for fasteners, connectors, and any other metal that will be in contact with preservative treated wood.

2. Treatment processes

Treatment processes may use any combination of atmospheric air, initial air pressure, or vacuum and pressure that will achieve the desired results without damaging the wood.

3. Preservatives

The wood shall be treated with the specified type of preservative.

4. Quality of treated material

Treated lumber, timber, piles, poles, or posts shall be free from heat checks, water bursts, excessive checking, chafing damage, or from any other damage or defects that would impair their usefulness or durability for the purpose intended. The use of s-irons is not permitted. Holes bored for tests shall be filled with tight fitting, treated wood plugs.

5. 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; treatment company name and location; names of the preservative components; treatment end use category; minimum retention; and the applicable AWPA treatment standard or the number of the evaluation report from an evaluation service recognized by the International Code Council at *http://www.iccsafe.org*.

6. Fasteners and Connectors

All fasteners, connectors, and any other metal contacting preservative treated wood shall be hot-dip galvanized or stainless steel. Unless otherwise specified, all fasteners, connectors, and any other metal contacting alkali copper quaternary (ACQ) or copper azole (CA) treated wood shall be stainless steel. 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.

Manufactured by:
Agri Drain CORPORATION

PO Box 458 · 1462 340th Street · Adair, Iowa 50002
Phone: 1-800-232-4742 · Fax: 1-800-282-3353
www.agridrain.com · email: info@agridrain.com

Rat Guards™

Avoid irritating and costly plugged drainage systems with stainless steel Rat Guards and zinc dichromate-plated mild steel Rat Guards.

Rat Guard, Stainless Steel

- Stainless steel material and hardware provides extended life.
- Resists rust and corrosion.
- Easy to install.
- 18" and 24" Rat Guards are held in place with a steel rod (included) which extends through the frame and then through the pipe. The rod extends approximately 1" on either side of frame.

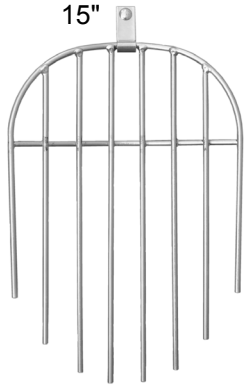
Discount available when purchased in case quantity. Cases available on 4"–100 per case, 6"–100 per case, 8"–50 per case, 10"–30 per case, 12"–30 per case, and 15"–10 per case.

All bars are MIG welded on both sides.

Rat Guard, Mild Steel

- Zinc dichromate plating resists corrosion.
- Easy to install. Position far enough in the pipe to allow it to swivel up and let trash pass without exposing the Rat Guard beyond the pipe.
- 18" through 60" Rat Guards are held in place with a steel rod (included) which extends through the frame and then through the pipe. Rod extends approximately 1" on either side of frame.

Discount available when purchased in case quantity. Cases available on 4"–100 per case, 6"–100 per case, 8"–50 per case, 10"–30 per case, 12"–30 per case, and 15"–10 per case.



Size	Diameter of Steel Frame & Center Bars	Approx. Bar Spacing	Steel Strap Size	Bolt Size
4"	1/4"	1"	1/8" x 3/4"	1/4" x 1 1/4"
6"	1/4"	1.04"	1/8" x 3/4"	1/4" x 1 1/4"
8"	1/4"	1.06"	1/8" x 3/4"	1/4" x 1 1/4"
10"	5/16"	1.17"	1/8" x 1"	5/16" x 1 1/2"
12"	5/16"	1"	1/8" x 1"	5/16" x 1 1/2"
15"	5/16"	1.38"	1/8" x 1"	5/16" x 1 1/2"

Size	Diameter of Center Bars	Approx. Bar Spacing	Square Steel Frame	Steel Rod Size
18"	5/16"	1.19"	3/4"	3/8"
21"	5/16"	1.19"	3/4"	3/8"
24"	5/16"	1.19"	1"	3/8"
30"	5/16"	1.19"	1"	3/8"
36"	5/16"	1.19"	1"	3/8"
42"	1/2"	1"	3/4" / 1"	1/2"
48"	1/2"	1"	3/4" / 1"	1/2"
54"	1/2"	1.5"	1 1/4" / 1 1/2"	1/2"
60"	1/2"	1.5"	1 1/4" / 1 1/2"	1/2"